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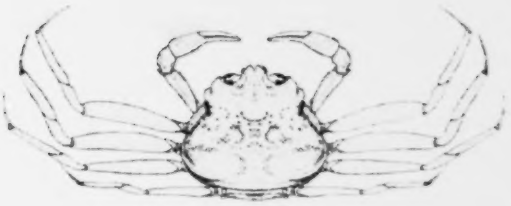
Newfoundland and Labrador Region
Canadian Science Advisory Secretariat
Science Advisory Report 2010/020

ASSESSMENT OF NEWFOUNDLAND AND LABRADOR SNOW CRAB



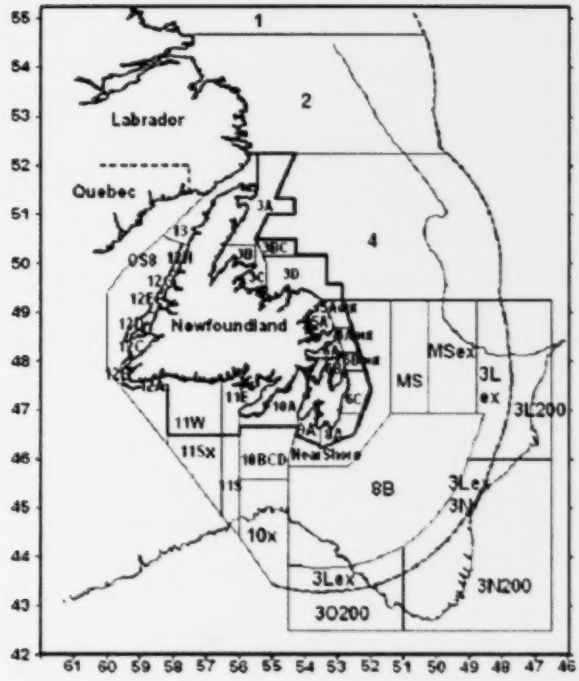


Figure 1: Newfoundland and Labrador Snow Crab Management Areas (CMAs). Red line segregates inshore from offshore CMAs.

Context

Snow crab (Chionoecetes opilio) occur over a broad depth range in the Northwest Atlantic from Greenland to the Gulf of Maine. Distribution in waters off Newfoundland and southern Labrador is widespread and continuous.

Crab harvesters use fleets of conical baited traps. The minimum legal size is 95 mm carapace width (CW). This regulation excludes females from the fishery while ensuring that a portion of the adult males in the population remains available for reproduction.

Total Allowable Catch (TAC) management was initiated in the late 1980's. This led to the development of multiple TAC-controlled management areas (Fig. 1) with about 3200 licence holders across several vessel fleets under enterprise allocation in 2009. All fleets have designated trap limits, quotas, trip limits, fishing areas within divisions, and differing seasons.

Stock status is assessed annually for inshore and offshore areas (where applicable) within each NAFO Division. A vessel monitoring system (VMS) was fully implemented in the offshore fleets in 2004.

Resource status is evaluated based on trends in fishery catch per unit of effort (CPUE), exploitable biomass indices, recruitment prospects, and mortality indices. Data are derived from multi-species bottom trawl surveys in Div. 2HJ3KLNOP, DFO inshore trap surveys in Div. 3KL, fishery data from logbooks, observer catch-effort data, industry-DFO collaborative trap survey data, as well as biological sampling data from multiple sources.

A meeting of the Regional Advisory Process (RAP) was held Feb. 24-26 and March 1-5, 2010 in St. John's, NL to assess the status of the snow crab resource. Participants included DFO scientists, fisheries managers, and representatives from industry, and the provincial government.

Canada

SUMMARY

- Total **landings** increased by 22% since 2005 to 53,500 t in 2009.
- The multi-species trawl surveys indicate that the overall **exploitable biomass** has recently increased due to recovery in the south (Div. 3LNOPs) while the north (Div. 2HJ3K) has decreased.
- **Recruitment** has recently increased overall due to recovery in the south.
- Longer-term recruitment prospects are uncertain.

Division 2H

- Landings declined by 53% from 190 t in 2007 to 90 t in 2009, while effort decreased by 24%.
- The **exploitable biomass** has decreased in recent years. The post-season trawl survey exploitable biomass index doubled between 2004 and 2006, but decreased by 66% to 2008. There was no trawl survey in 2009.
- **Recruitment** has decreased since 2004 and is expected to be low over the next several years.
- The effect of maintaining the current level of fishery removals on the exploitation rate in 2010 is unknown.

Division 2J

- **Landings** increased by 60% from 2005-2008. They remained unchanged in 2009, while **effort** increased by 27%.
- **CPUE** increased from 2004-2008 to the long-term average, but decreased in 2009.
- The **exploitable biomass** has decreased in recent years. The post-season trawl survey exploitable biomass index peaked in 2006 and has since declined steadily.
- **Recruitment** has recently declined and is expected to remain low for 2010. It is expected to change little in the short term following 2010. The post-season trawl survey pre-recruit index decreased sharply in 2005 and has since fluctuated without trend
- The **exploitation rate index** and the **pre-recruit fishing mortality index** both declined sharply from 2003-2005. While the pre-recruit index has remained low since that time, the exploitation rate index continued to decline to 2007 before increasing to 2009.
- Maintaining the current level of fishery removals while biomass is declining will result in an increase in the exploitation rate in 2010.

Division 3K Offshore

- After decreasing sharply to 6,000 t in 2005, **landings** more than doubled to 13,000 t in 2009. Meanwhile **effort** declined sharply in 2005 and changed little until it increased by 70% in 2009. Landings and effort have returned to pre-2005 levels.
- **CPUE** increased sharply from 2005 to a record high level in 2008, and then decreased sharply in 2009.
- The **exploitable biomass** decreased substantially since 2007. Post-season exploitable biomass indices from both trap and trawl surveys increased in 2006 and to 2007, respectively. Both indices then remained at high levels until they decreased abruptly in 2009.
- **Recruitment** decreased in 2009 as reflected by the abrupt decrease in the post-season exploitable biomass while landings increased little. It is expected to be further reduced for 2010, but longer term prospects remain uncertain.

- The trawl survey **exploitation rate index** increased slightly in 2009 following a decline since 2006. The **pre-recruit fishing mortality index** decreased sharply in 2006 and changed little until it more than doubled in 2009.
- Maintaining the current level of fishery removals would likely result in an increase in the **exploitation rate** and high mortality on soft-shelled immediate pre-recruits in 2010.

Division 3K Inshore

- **Landings** increased by 33% from 2,700 t in 2005 to 3,600 t in 2009. **Effort** declined from 2004 to 2008 and increased by 42% in 2009.
- **CPUE** increased sharply from 2005 to a record high level in 2008 but decreased in 2009.
- The **exploitable biomass** decreased in 2009. The collaborative fall trap survey exploitable biomass index changed little during 2004-2008 before decreasing substantially in 2009.
- **Recruitment** decreased in 2009 as reflected by the substantial decrease in the post-season exploitable biomass while landings increased little. It is expected to decrease further in 2010 and longer term prospects are uncertain.
- The trap survey-based **exploitation rate index** changed little since 2005. Data are insufficient to estimate **pre-recruit mortality** rates.
- Maintaining the current level of fishery removals would likely increase the exploitation rate in 2010.

3LNO Offshore

- **Landings** remained at 22,000-25,000 t since 2000. **Effort** increased steadily from 2000-2007 and changed little since.
- **CPUE** declined steadily from 2000-2008, to the lowest level since 1991, and was unchanged in 2009.
- The **exploitable biomass** has recently increased. The exploitable biomass index from the trawl survey declined steadily from 2001-2007 but has since more than doubled. The trap survey index declined steadily from 2004-2008 but increased in 2009.
- Both post-season surveys indicate that **recruitment** has been increasing and is expected to increase further over the next two to three years.
- Both the **exploitation rate index** and the **pre-recruit fishing mortality rate index** peaked in 2008 but decreased in 2009. The latter index was at its lowest level in 2009.
- Increased removals would not likely increase the exploitation rate in 2010.

3L Inshore

- **Landings** increased by 15% from 6100 t in 2005 to 7,000 t in 2009. **Effort** decreased by 23% from 2005-2008, but increased by 11% in 2009.
- **CPUE** increased by 53% from 2004 to 2008 before decreasing slightly in 2009.
- The post-season trap survey index indicates the **exploitable biomass** has declined gradually since 2006.
- Overall, **recruitment** prospects have recently improved, but there is considerable spatial variability.
- The trap survey-based **exploitation rate index** changed little from 2005-2007 but has since increased. Data are insufficient to estimate **pre-recruit mortality** rates.

- Maintaining the current level of fishery removals would likely result in little change in the **exploitation rate** but may increase mortality on soft-shelled immediate pre-recruits in some areas in 2010.

Subdivision 3Ps Offshore

- **Landings** increased by 57% from 2,300 t in 2006 to 3,600 t in 2009. **Effort** decreased by 26% in 2008 to its lowest level since 2001 and was unchanged in 2009.
- **CPUE** has increased by 72% since 2007 and is approaching the long-term average.
- The **exploitable biomass** has recently increased. The pre-season trawl survey exploitable biomass index increased since 2007 while the post season trap survey index more than doubled since 2004.
- **Recruitment** has recently increased as reflected by an increase in biomass while landings increased. Recruitment prospects remain promising for the short-term following 2010. Since 2005, the pre-season trawl survey pre-recruit index has steadily increased while the post-season trap survey index has varied without trend.
- **Exploitation and pre-recruit mortality rate indices** based on trap and trawl surveys have both decreased since 2007. The pre-recruit index is at its lowest level since 1996.
- Fishery removals could likely be marginally increased in 2010 without increasing the exploitation rate.

Subdivision 3Ps Inshore

- **Landings** more than doubled from 700 t in 2005 to 1,900 t in 2009 while **effort** declined slightly.
- **CPUE** more than doubled since 2005 to exceed the long-term average.
- The **exploitable biomass** appears to have peaked. The post-season trap survey exploitable biomass index increased substantially from 2006-2008 but decreased slightly in 2009.
- **Recruitment** has decreased for 2010 but longer-term prospects remain promising. The post-season trap survey pre-recruit biomass index peaked in 2007 and has since decreased to remain above the 2004-2006 level
- The post-season trap survey-based **exploitation rate index** fluctuated without trend during 2005-2009. Data are insufficient to estimate **pre-recruit fishing mortality** rates.
- Maintaining the current level of fishery removals would likely result in a slight increase in the exploitation rate in 2010.

Division 4R Offshore

- **Landings** and **effort** have been variable in recent years after reaching historical lows in 2006. The TAC has not been achieved since 2002.
- **CPUE** has remained below the long-term average since 2003.
- The **exploitable biomass** is low as reflected by poor fishery performance since 2004.
- **Recruitment** has been low in recent years. Longer-term recruitment prospects are unknown.
- The effect of maintaining the current level of fishery removals on the **exploitation rate** is unknown.

Division 4R Inshore

- **Landings** and **effort** have steadily declined since 2004, to historical lows in 2009. The TAC has not been achieved since 2002.
- **CPUE** has steadily declined since 2002 to its lowest level in 2009.
- Post-season trap survey catch rates show that the **exploitable biomass** has remained low since 2005.
- **Recruitment** is expected to remain low for 2010. It is expected to increase in the short term following 2010, but there is considerable spatial variability.
- Maintaining the current level of fishery removals would have an unknown effect on the **exploitation rate** but may increase mortality on soft-shelled immediate pre-recruits in some areas in 2010.

BACKGROUND

Species Biology

The snow crab life cycle features a planktonic larval period, following spring hatching, involving several stages before settlement. Benthic juveniles of both sexes molt frequently, and at about 40 mm carapace width (CW) (~ 4 years of age) they may become sexually mature.

Crabs grow by molting, in spring. Females cease molting after sexual maturity is achieved at about 40-75 mm CW and so do not contribute to the exploitable biomass. However sexually mature (adolescent) males may continue to molt annually until their terminal molt, when they develop enlarged claws (adults), which enhances their mating ability. Males may molt to adulthood within a size range of about 40-115 mm CW, and so only a portion of any cohort will recruit to the fishery at 95 mm CW (~ 8 years of age).

Adult legal-sized males remain new-shelled with low meat yield throughout the remainder of the year of their terminal molt. They are considered to be pre-recruits until the following year when they begin to contribute to the exploitable biomass as older-shelled adults. Males may live about 6-8 years as adults after the terminal molt.

Large males are most common on mud or mud/sand, while smaller crabs are common on harder substrates. Snow crab diet includes fish, clams, polychaete worms, brittle stars, shrimp, snow crab, and other crustaceans. Predators include various groundfish, other snow crabs, and seals.

The Fishery

The fishery began in Trinity Bay (Management area 6A, Fig. 1) in 1967. Initially, crabs were taken as gillnet by-catch but within several years a directed trap fishery developed in inshore areas along the northeast coast of Div. 3KL. The minimum legal mesh size of traps is 135 mm, to allow small crabs to escape. Under-sized and new-shelled males that are retained in the traps are returned to the sea and an unknown proportion dies.

Until the early 1980's, the fishery was prosecuted by approximately 50 vessels limited to 800 traps each. In 1981 fishing was restricted to the NAFO Division adjacent to where the licence holder resided. During 1982-1987 there were major declines in the resource in traditional areas

in Div. 3K and 3L while new fisheries started in Div. 2J, Subdiv. 3Ps and offshore Div. 3K. A snow crab fishery began in Div. 4R in 1993.

Licences supplemental to groundfishing were issued in Div. 3K and Subdiv. 3Ps in 1985, in Div. 3L in 1987, and in Div. 2J in the early 1990's. Since 1989 there has been a further expansion in the offshore. Temporary permits for inshore vessels <35 ft., introduced in 1995, were converted to licences in 2003. There are now several fleet sectors and about 3200 licence holders.

In the late 1980's quota control was initiated in all management areas of each division. All fleets have designated trap limits, quotas, trip limits, fishing areas within divisions, and differing seasons. The fishery has started earlier in recent years and is now prosecuted predominately in spring, resulting in reduced incidence of soft-shelled crabs. A protocol was initiated in 2004 that results in closure of localized areas when the percent soft-shelled crabs within the legal-sized catch exceeds 20%.

Mandatory use of the electronic vessel monitoring system (VMS) was fully implemented in all offshore fleets in 2004, to ensure compliance with regulations regarding area fished.

Landings for Div. 2HJ3KLNOP4R (Fig. 2) increased steadily from 1989 to peak at 69,100 t in 1999, largely due to expansion of the fishery to offshore areas. They decreased by 20% to 55,400 t in 2000 and changed little until they decreased to 44,000 t in 2005, primarily due to a sharp decrease in Div. 3K where the TAC was not taken. Landings increased by 22% since 2005 to 53,500 t in 2009, due primarily to increases in Div. 3K. Historically, most of the landings have been from Div. 3KL. Effort has increased since the 1980's and has been broadly distributed in recent years (Fig. 3).

The fishery was delayed in northern divisions (Div. 2J and 3K) in 2009 due to severe ice conditions. Late fishing seasons are believed to contribute to a high incidence of soft-shelled immediate pre-recruits in the catch. Such severe ice conditions can affect the spatial distribution of fishing effort and fishery performance.

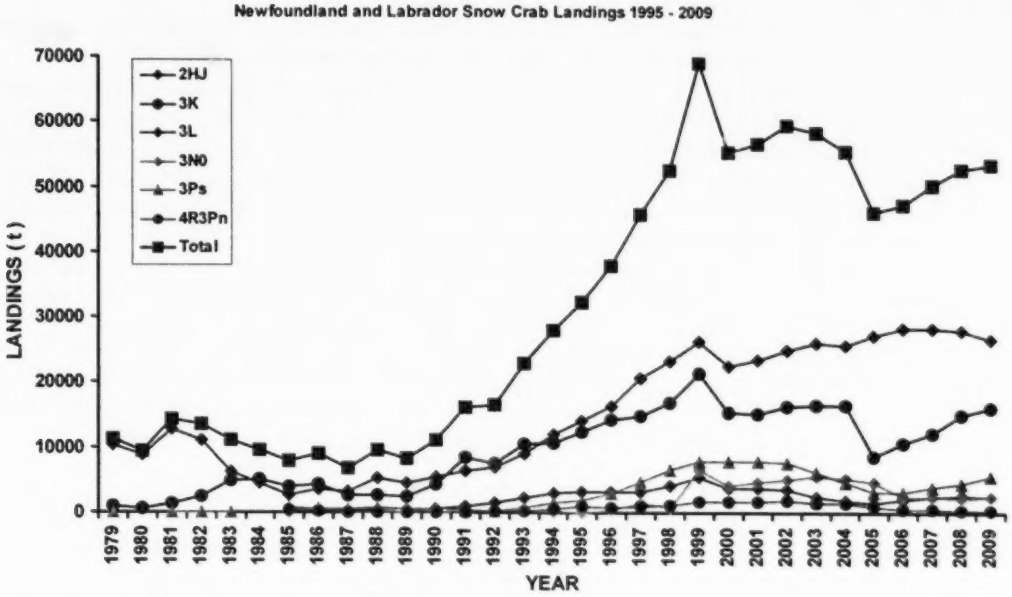


Figure 2: Trends in landings by NAFO Division and in total.

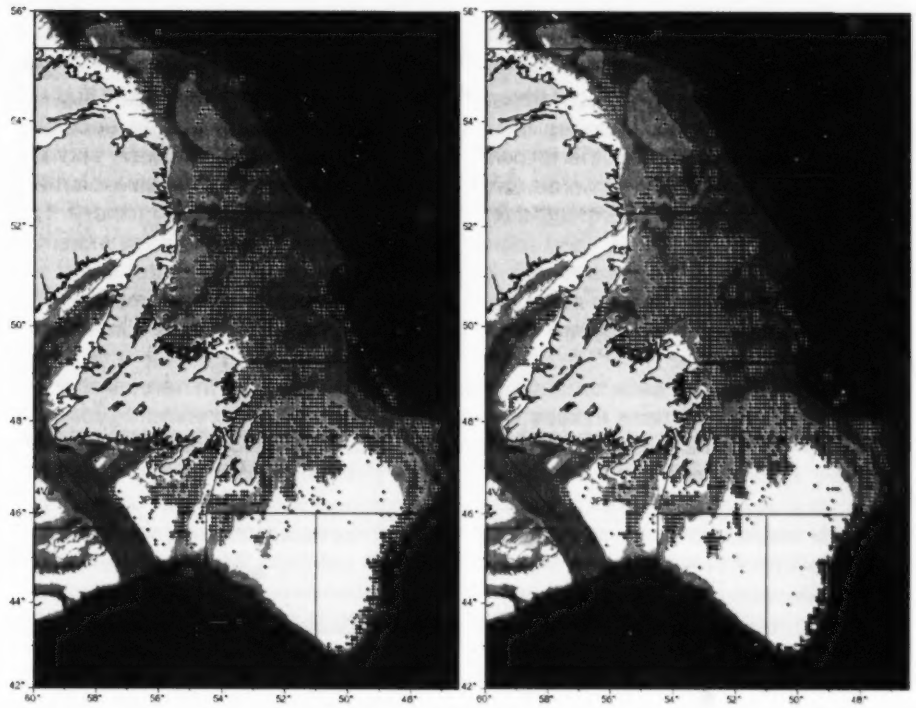


Figure 3: Spatial distribution of commercial fishing effort during 2008 and 2009.

ASSESSMENT

Resource status was evaluated based on trends in fishery **CPUE**, **exploitable biomass indices**, **recruitment** prospects and **mortality indices**. Information was derived from multi-species bottom trawl surveys conducted during fall in Div. 2HJ3KLNO and during spring in Subdiv. 3Ps. The trawl used in these multi-species surveys was changed to a Campelen shrimp trawl in the fall of 1995 and this trawl proved to be more efficient in sampling crabs than the previously used groundfish trawl. Snow crab sampling during spring Subdiv. 3Ps surveys did not begin until 1999. The fall post-season trawl survey was conducted in Div. 2H during 1996-1999, 2001, 2004, 2006 and 2008. Spring (pre-fishery) trawl surveys are considered to be less reliable than fall (post-fishery) surveys because some population components are relatively poorly sampled during spring when mating and molting take place. Information was also available from a fall Industry-DFO collaborative post-season (CPS) trap survey initiated in 2003. Fall post-season surveys provide the most recent data available for the annual RAP. Information is also utilized from DFO inshore trap and trawl surveys in Div. 3KL, fishery data from logbooks and observer catch-effort data, as well as biological sampling data from multiple sources.

The resource is assessed separately for offshore and inshore areas of each division, where appropriate (Div. 3KLPs4R; there is no distinction between inshore and offshore areas in Div. 2HJ (Fig. 1)). Div. 3LNO is assessed as a unit because the offshore fishery is managed at that spatial scale and data for Div. 3NO, a fully offshore area (Fig. 3), are inadequate to assess those divisions separately. More data are available in most divisions for offshore than for inshore areas. Trawl survey data are used only for offshore areas because these surveys have not consistently extended into inshore areas. Observer coverage and sampling has also been more extensive in offshore than inshore areas. Also, vessel monitoring devices are used only on offshore vessels.

Spring pre-season (Subdiv. 3Ps) and fall post-season (Div. 2HJ3KLNO) bottom trawl surveys provide data that are used to predict changes in biomass and recruitment for the upcoming fishery in the same year (Subdiv. 3Ps) or the following year (Div. 2HJ3KLNO). These surveys, based on a stratified random sampling scheme, provide an index of the exploitable biomass (older-shelled adults of legal size) that is expected to be available for the upcoming fishery. This index, based on offshore survey strata, is used together with an exploitable biomass index (all legal-sized crabs) from the CPS trap survey in offshore areas to evaluate trends in the exploitable biomass. The inshore CPS trap survey exploitable biomass index is compared with commercial CPUE and catch rates from inshore DFO trap surveys, where available (Div. 3KL).

Bottom trawl surveys also provide data on recruitment. Recent changes in recruitment are inferred from changes in survey biomass indices in relation to landings. Recruitment prospects for the upcoming fishery (in the next year) are inferred from biomass indices or catch rates of new-shelled legal-sized adults (immediate pre-recruits) from post-season trawl surveys. Trawl surveys also provide an index of pre-recruit biomass, based on adolescents larger than 75 mm CW. These adolescents would recruit in the short term (about 2-3 years) following the upcoming fishery. Short-term recruitment prospects are also inferred from biomass indices or catch rates of sub-legal-sized ('under-sized') males from observer at-sea sampling and post-season trap surveys. However, these males include an unknown portion of sub-legal-sized adults (terminally molted) that will never recruit.

Trawl surveys also provide abundance indices for males of all sizes. There is little evidence of annual progression of smallest males (< 40 mm CW) to successively larger sizes from spring or fall multi-species survey size frequency data. Therefore, longer-term (ie. >3 years) recruitment prospects are uncertain.

In previous assessments trawl survey abundance and biomass indices were calculated based on a set of common strata that were sampled in all years in the multi-species surveys. Due to gradual attrition of common strata over time, a set of "core strata" was selected for this assessment which included strata most consistently sampled throughout the time series. This group of core strata captured strata that were common to most years, especially recent years, and does not include inshore strata or deep (>750 m) slope strata that have not been regularly sampled.

The CPS trap survey, based on a fixed-station grid design, is more spatially limited than the trawl survey as it targets only portions of commercial fishing grounds. Stations selected from this survey were changed from common stations to a set of core stations in the present assessment, due to gradual attrition of common stations. Biomass indices derived from this survey were based on the same stratification scheme as those from the trawl survey. For the present assessment, strata were chosen to best conform with fishing areas in inshore or offshore zones of each division (Fig. 1).

Fishery-induced mortality is a function of the proportion of the exploitable population that is harvested and the proportion of the pre-recruit population that dies as a result of being caught and released. Trends in exploitation rate are inferred from changes in the ratio of landings to the exploitable biomass index from the most recent trap and trawl surveys. Trends in pre-recruit fishing mortality are inferred from changes in the ratio of the estimated total catch of pre-recruits to the trawl survey biomass index of pre-recruits plus undersized adults from the most recent trawl survey. The total catch of pre-recruits is estimated as the ratio of observed discards to observed landings scaled to total landings. Mortality indices based on post-season trap surveys use biomass indices from the previous year. Those based on trawl surveys use the biomass indices from either the fall post-season survey of the previous year (Div. 2HJ3KLNO) or the spring pre-season survey of the same year (Subdiv. 3Ps).

The pre-recruit fishing mortality index reflects an unknown (but likely high) mortality on released pre-recruits. Pre-recruit mortality is reduced by careful handling and quick release of pre-recruits. Mortality on sub-legal-sized males, including adolescent pre-recruits, can also be reduced by increasing trap mesh size and soak time. Prevalence of soft-shelled crabs in the fishery is believed to be a function of both seasonal timing and biomass level. Mortality on soft-shelled legal-sized immediate pre-recruits can be minimized by fishing early in spring before recently-molted crabs are capable of climbing into traps. It may be further reduced by maintaining a relatively high exploitable biomass level, thereby maintaining strong competition for baited traps and low catchability of less-competitive immediate pre-recruits.

The percentage discarded by weight of the total catch, as estimated from observer data, is interpreted as an index of wastage of pre-recruits. Mortalities on pre-recruits, including wastage, will impact short-term (about 1-3 years) recruitment. Also, mortality on small (<95 mm CW) males may adversely affect insemination of females, especially when abundance of larger males is low.

Overall Resource Status, Divisions 2HJ3KLNOP4R

The multi-species trawl surveys indicate that the **exploitable biomass** declined from the late 1990's to 2003-2004, but has since increased (Fig. 4). The fall post-season surveys in Div. 2J3KLNO indicate that the exploitable biomass was highest during 1996-1998. The more limited time series from spring multi-species surveys in Div. 3LNOPs also indicated a decline in exploitable biomass in the early years of the surveys. The spring and fall surveys both showed

decreases in the exploitable biomass indices from 2001 to 2003-2004, with little change until the fall index increased in 2007. Most of the increase was due to recovery in the south (Div, 3LNOPs) while the north (Div. 2HJ3K) has decreased, as reflected in the divisional trends. There has been little change overall in both spring and fall indices over the past 3 years (Fig 4).

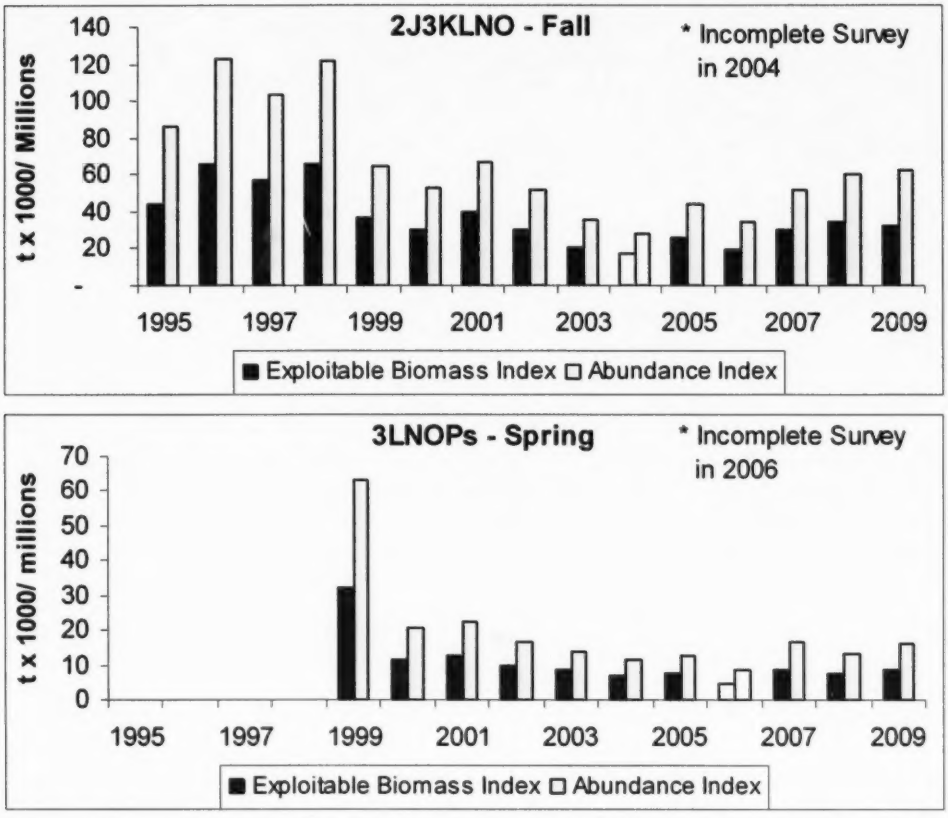


Figure 4: Trends in the multi-species survey exploitable biomass and abundance indices, for Div. 2J3KLNO during fall (above) and for Div. 3LNOPs during spring (below).

Recruitment has recently increased overall (Fig. 5). The survey abundance and biomass indices of pre-recruits have been increasing since 2005 due to increases in the south (Div. 3LNOPs).

Longer-term recruitment prospects are uncertain but the spring and fall surveys indicate that there has been a decline in abundance indices of smallest males (<40 mm CW) that may indicate reduced biomass in the long term. This index for smallest males has been relatively low since 2004.

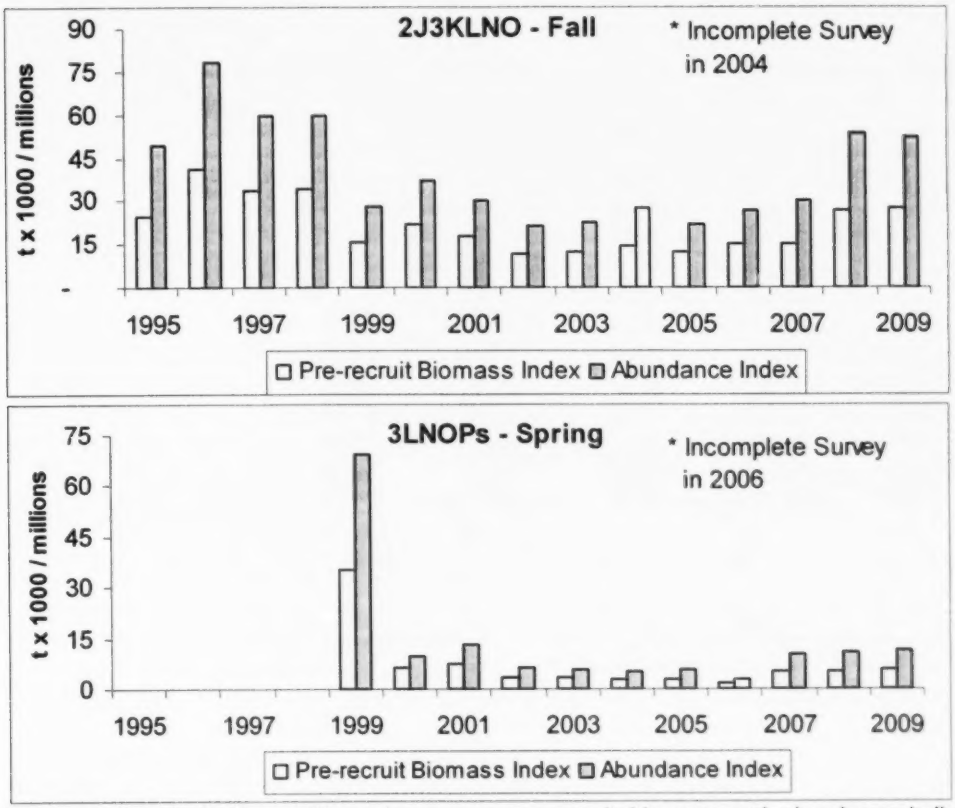


Figure 5: Trends in the multi-species survey pre-recruit biomass and abundance indices for Div. 2J3KLNO during fall (above) and for Div. 3LNOPs during spring (below).

Resource Status, Division 2H

Commercial Fishery

There have been exploratory fisheries since the mid 1990's. A commercial TAC was first established in 2008, and maintained in 2009, at 100 t (Fig. 6). Landings increased from 70-190 t during 2005-2007. They subsequently declined by 53% to 90 t in 2009, while effort decreased by 24%.

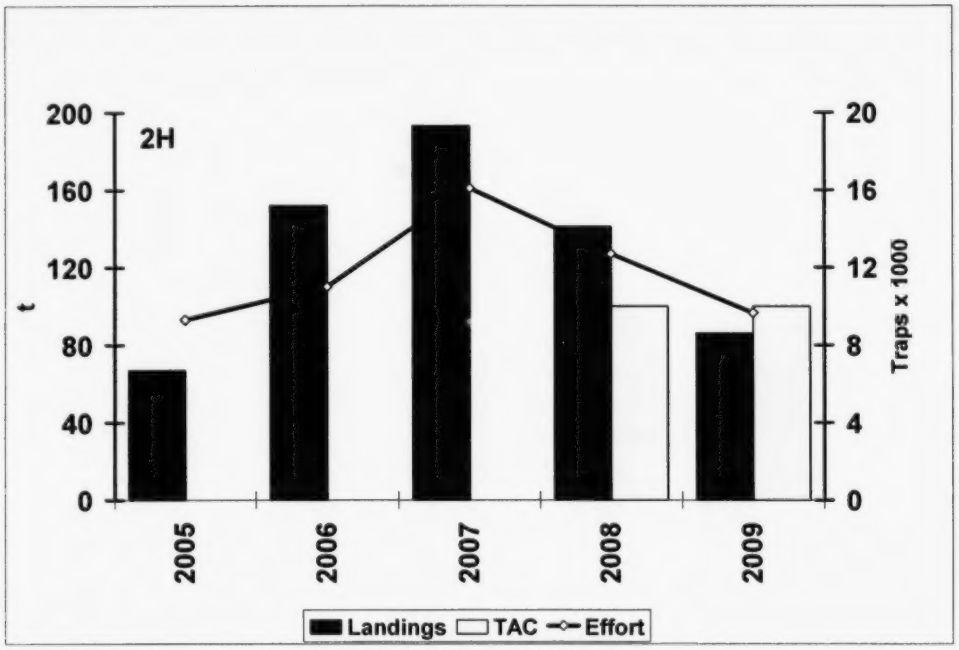


Figure 6: Trends in TAC, landings, and fishing effort in Div. 2H.

Biomass

The **exploitable biomass** decreased in recent years. The post-season trawl survey exploitable biomass index doubled between 2004 and 2006, but then decreased by 66% to 2008 (Fig. 7). There was no survey in 2009

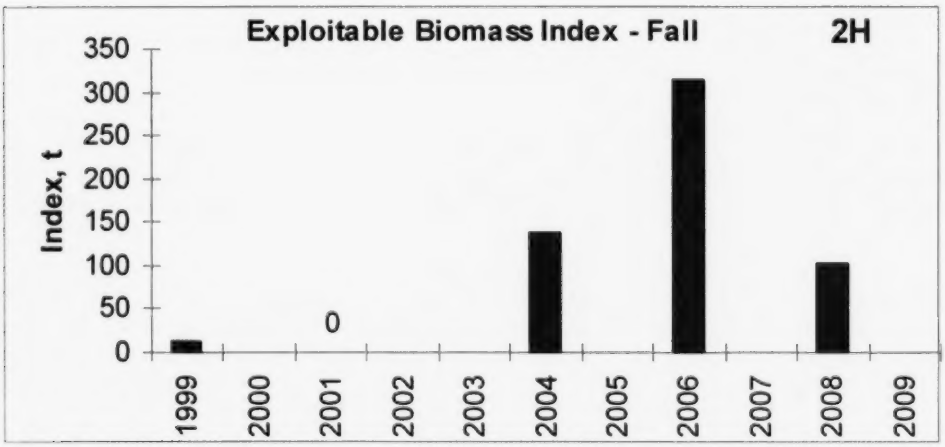


Figure 7: Trends in the Div. 2H exploitable biomass index based on the post-season trawl survey.

Recruitment

Recruitment has decreased since 2004 and is expected to be low over the next several years. The post-season trawl survey pre-recruit index decreased greatly between 2004 and 2008 (Fig. 9).

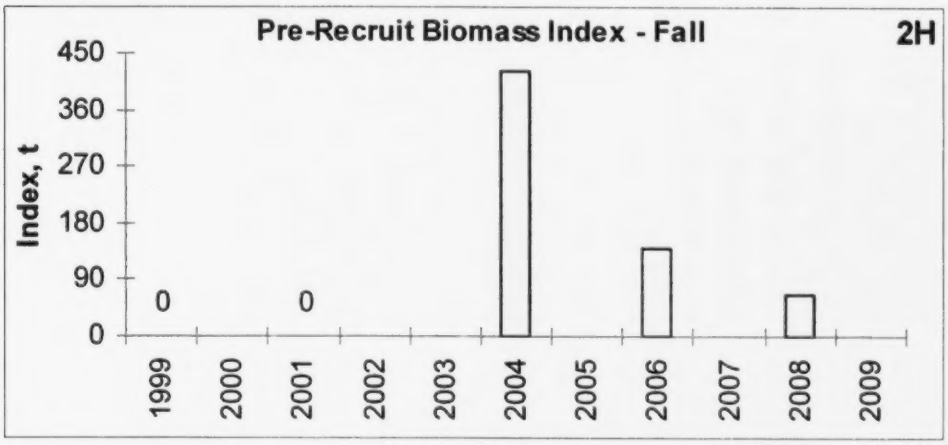


Figure 8: Trends in the Div. 2H pre-recruit biomass index based on the post-season trawl survey.

Mortality

There are no data for 2009 that could be used to predict effects of changes in harvest level on mortality.

Resource Status, Division 2J

Commercial Fishery

Landings (Fig. 9) peaked in 1999 at 5,420 t, decreased sharply to 3,680 t in 2000 and changed little to 2002, before declining to 2005. They increased by 60% from 1,500 t in 2005 to 2,410 t in 2008. **Effort** increased from 2000 to a record high level in 2002-2004. It decreased sharply in 2005 and further declined by 18% to 2008. Landings were virtually unchanged at 2,300 in 2009 while effort increased by 27%.

The 2009 fishery was concentrated in Hawke and Cartwright channels, as it was in the previous three years. In 2006-2009 there was limited fishing on the slope relative to previous years. The fishery in 2009 was delayed due to severe ice conditions.

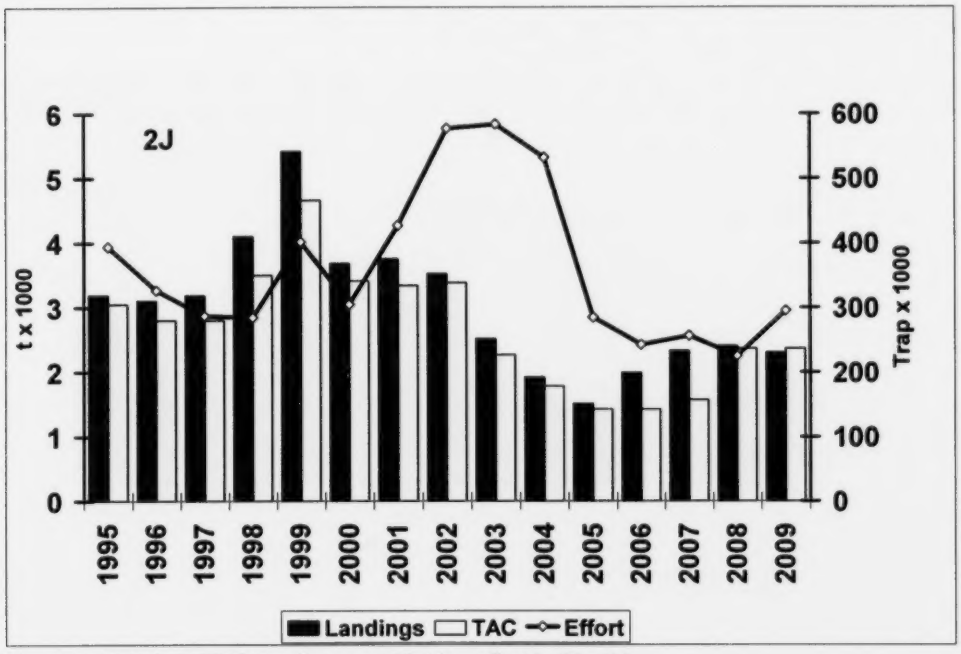


Figure 9: Trends in TAC, landings, and fishing effort in Div. 2J.

Commercial catch rate (**CPUE**) has oscillated over the time series (Fig. 10), initially decreasing from 1991-1995, and increasing to a peak in 1998. It declined steadily by 76% from 1998 to a record low level in 2004. It has increased steadily from 2004-2008 to the long-term average, but decreased in 2009.

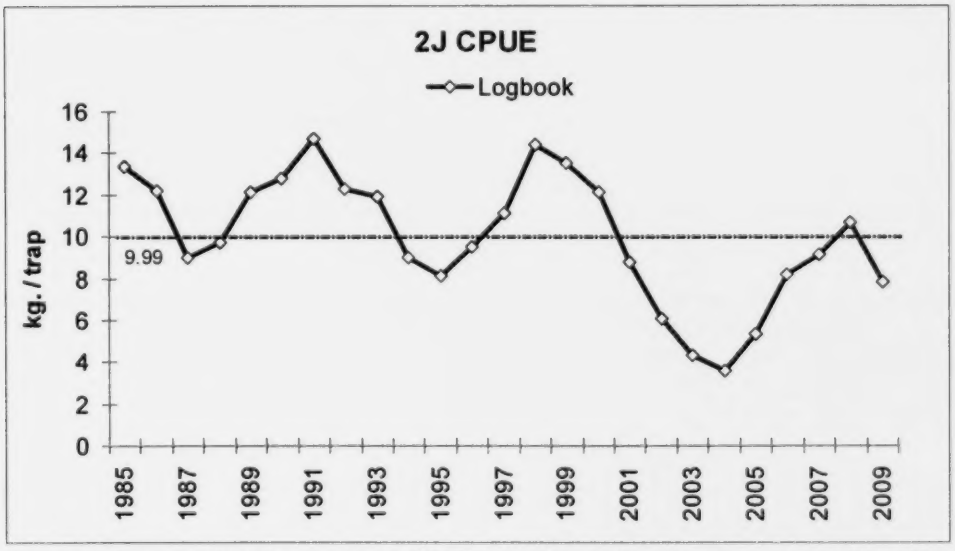


Figure 10: Trends in Div. 2J commercial CPUE in relation to the long-term average (dotted line).

Biomass

The **exploitable biomass** has decreased in recent years. The post-season trawl survey exploitable biomass index decreased steadily by 92%, from 1998-2002 (Fig. 11). It increased from 2002 to peak in 2006 but remained below pre-2002 levels. It has since declined steadily to 2009. The post-season trap survey index declined sharply from 2007-2009. However, that index reflects only the southern portion of the division.

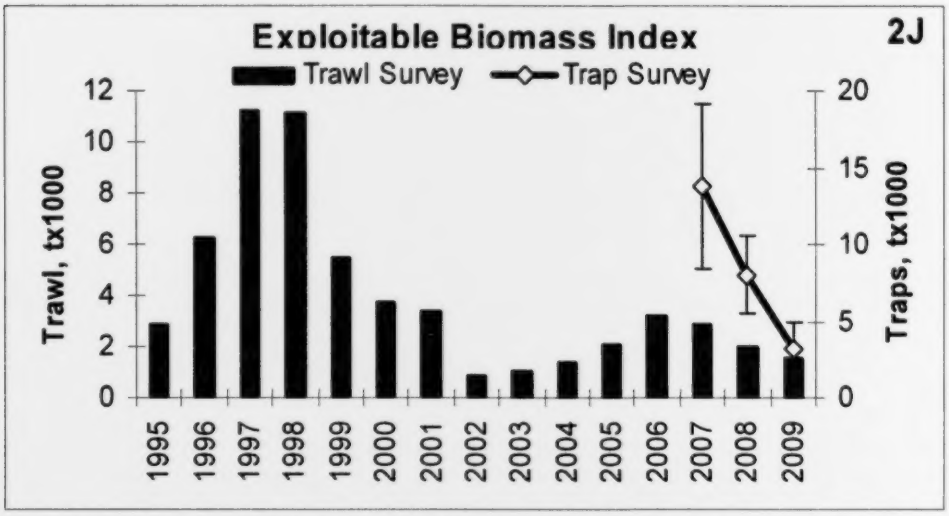


Figure 11: Trends in the Div. 2J exploitable biomass indices based on post season trawl and trap surveys. The trap survey is conducted only in the southern portion of the division.

Recruitment

Recruitment has been in decline since 2006 as reflected by the decline in exploitable biomass since 2006 while landings changed little. Recruitment is expected to remain low in 2010, as reflected by the continued decline in the post-season trawl survey biomass index of legal-sized new-shelled adults to 2009.

Recruitment is expected to change little in the short term following 2010. The fall survey **pre-recruit index** decreased from 1998 to a lower level during 1999-2003 (Fig. 12) before increasing sharply to a peak in 2004. It decreased sharply in 2005 and has since fluctuated without trend. The catch rate of under-sized crabs in the post-season trap survey (in the southern portion of the division) decreased from 2007-2009 (Fig. 12).

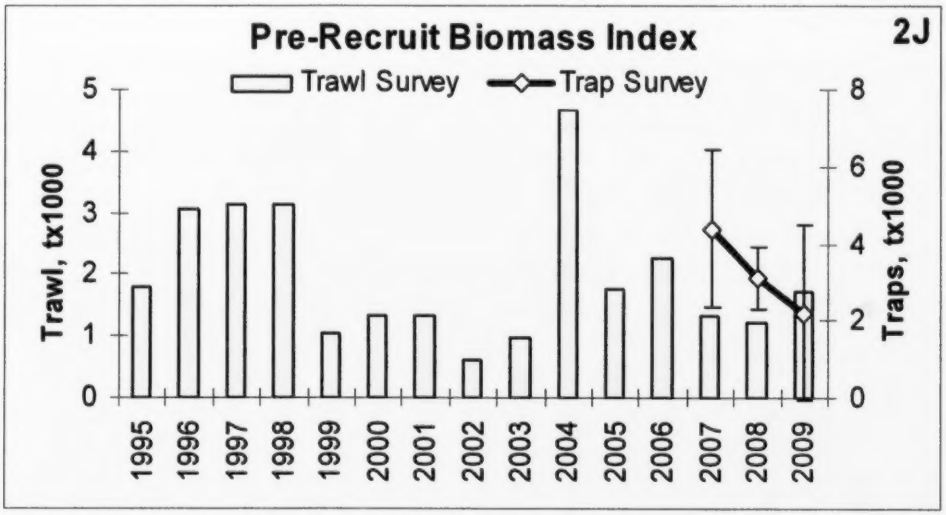


Figure 12: Trends Div. 2J pre-recruit biomass indices from the in the post-season trawl survey and the CPS trap survey. The trap survey is conducted only in the southern portion of the division.

Mortality

The percentage of the total catch discarded (Fig. 13) increased from 2001 to a record high level in 2004. It then declined sharply to its lowest level in 2008, implying reduced wastage of under-sized and new-shelled pre-recruits in the fishery. It increased in 2009 to remain relatively low, at about the 1999-2001 level.

The **exploitation rate index** and the **pre-recruit fishing mortality index** both declined sharply from 2003-2005 (Fig 13). While the pre-recruit index has remained low since that time, the exploitation rate index continued to decline to 2007 before increasing to 2009.

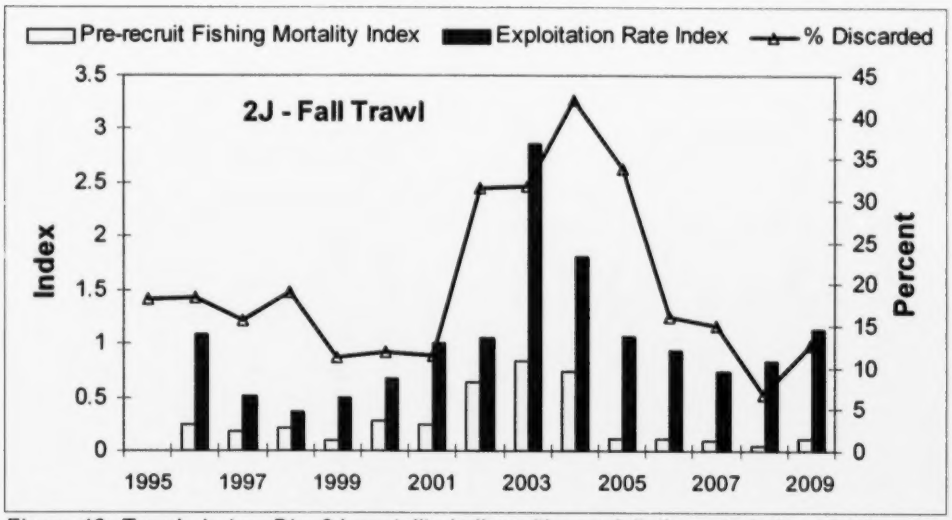


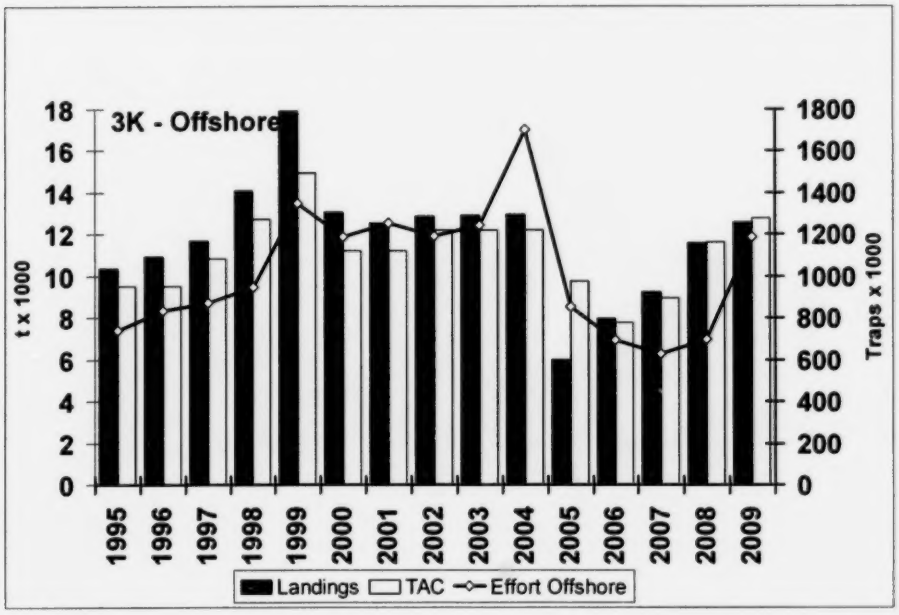
Figure 13: Trends in two Div. 2J mortality indices (the exploitation rate index and the pre-recruit fishing mortality index) and in the percentage of the catch discarded in the fishery.

Resource Status, Division 3K

Commercial Fishery

Offshore landings have generally been higher than inshore landings by a factor of 3-5 (Fig. 14). Offshore landings peaked in 1999 at 17,900 t. They decreased to about 13,000 t in 2000-2004, due to a reduction in the TAC. They decreased sharply in 2005 when the TAC was not fully subscribed because the fishery was closed prematurely due to high levels of soft-shelled crabs in the catch. **Landings** more than doubled since 2005 to 13,000 t in 2009. Meanwhile **effort** declined sharply in 2005 and changed little until it increased by 70% in 2009. Landings and effort have returned to pre-2005 levels.

Inshore landings (Fig. 14) peaked in 1999 at 3,460 t and decreased sharply in 2000 due to a TAC reduction. They increased to 3,340 t in 2003, changed little in 2004, and decreased by 21% in 2005. Landings increased by 33% from 2,700 t in 2005 to 3,600 t in 2009. **Effort** declined from 2004 to 2008 and increased by 42% in 2009.



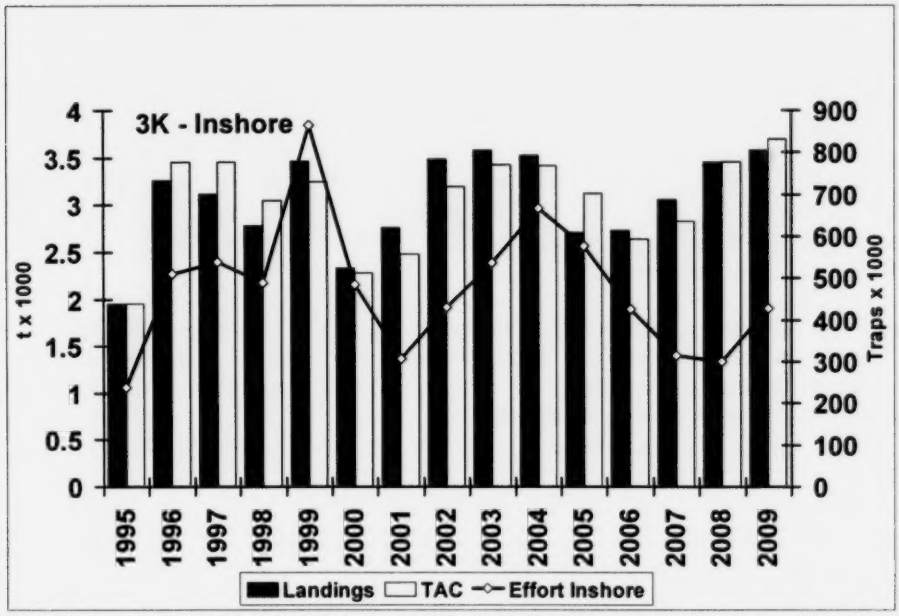


Figure 14: Trends in TAC, landings, and fishing effort in Div. 3K offshore (above) and inshore (below).

Commercial CPUE (Fig. 15) indicates deterioration of fishery performance in both inshore and offshore areas in 2009. Inshore CPUE has been consistently lower than offshore CPUE. Both offshore and inshore CPUE increased sharply from 2005 to record high levels in 2008 before decreasing in 2009.

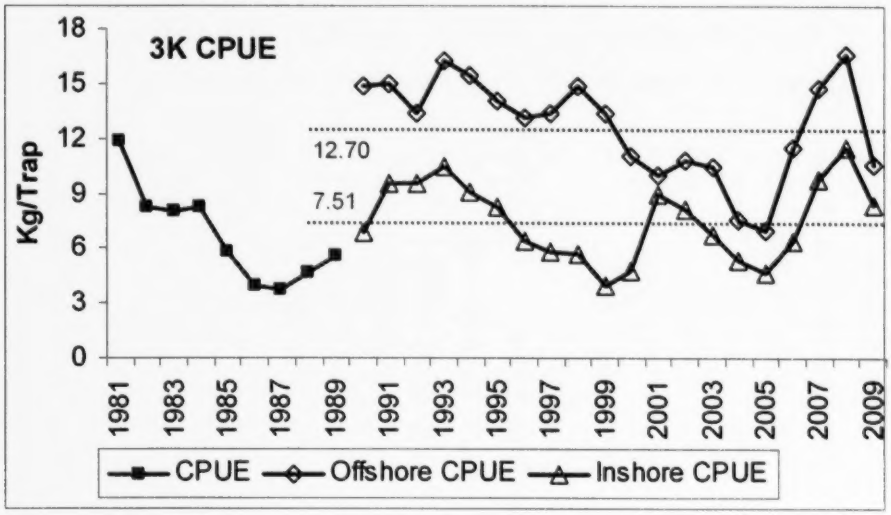


Figure 15: Trends in Div. 3K inshore and offshore commercial CPUE in relation to their long-term averages (dotted lines).

The large increase in offshore fishing effort and decrease in CPUE in 2009 may have been partly due to severe ice conditions early in the fishery and grid closures due to application of the soft-shelled protocol, that altered the spatial distribution of effort and adversely affected fishery performance. These factors may have also contributed to the spatial expansion of fishing effort evident in 2009, and expansion to depths greater than those usually fished.

Division 3K Offshore

Biomass

The **exploitable biomass** decreased substantially since 2007, as indicated by both post-season surveys. The post-season trawl survey **exploitable biomass index** (Fig. 16) decreased from its highest level in the late 1990's to its lowest in 2003 before increasing to 2007. The post-season trap survey exploitable biomass index increased in 2006 (Fig. 16). Both indices remained high to 2008 and decreased sharply in 2009.

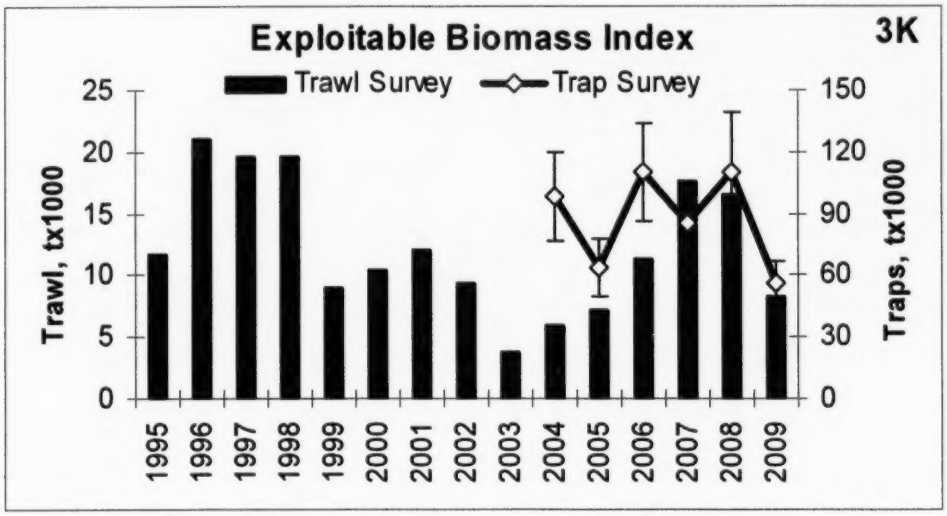


Figure 16: Trends in the Div. 3K offshore exploitable biomass indices based on post-season trawl and trap surveys.

Recruitment

Recruitment decreased in 2009, as reflected by the sharp decrease in the post-season exploitable biomass indices while landings increased little. Recruitment is expected to decrease further in 2010, as reflected by a decrease in biomass indices of legal-sized new-shelled adults in both 2009 post-season surveys. The decrease in recruitment for 2010 is believed to be largely due to high mortality on soft-shelled immediate pre-recruits in the 2009 fishery. The delayed season in 2009 likely contributed to the high incidence of soft-shelled crab in the fishery. Also, the expansion of effort across a broad depth range resulted in greater exposure of soft-shelled immediate pre-recruits to the fishery in 2009 than in previous years.

Recruitment prospects remain uncertain in the short term following 2010. The fall trawl survey **pre-recruit index** (Fig. 17) recently peaked in 2006 and has since fluctuated without trend. The post-season trap survey catch rate of undersized crabs has fluctuated throughout its limited time series (Fig. 17).

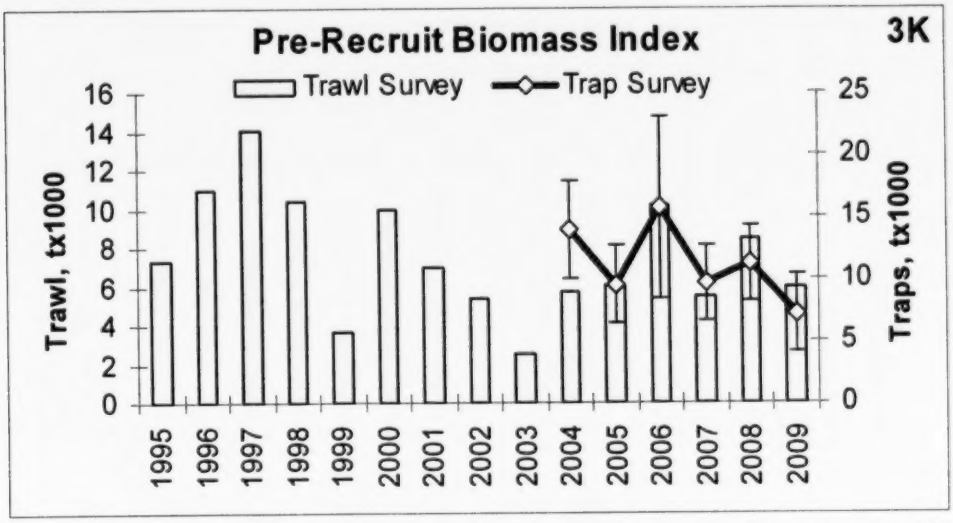


Figure 17: Trends in the Div. 3K offshore post-season trawl survey pre-recruit biomass index and in the catch rate of under-sized crabs from the post-season collaborative trap survey.

A group of small adolescents was apparent in the fall trawl survey size distributions at a modal size of about 65 mm CW in 2007. These adolescents contributed to the relatively high pre-recruit biomass index in the 2008 post-season survey (Fig. 17). While much of this potential recruitment was lost due to high handling mortality on soft-shelled immediate pre-recruits in the 2009 fishery, the pre-recruit biomass index from the 2009 post season survey remains within the range of the previous five years (Fig. 17).

Mortality

The percentage of the total catch discarded in the fishery (Fig. 18) decreased markedly in 2006 and continued to decline to its lowest value in 2008. It increased sharply in 2009, primarily due to a high incidence of soft-shelled immediate pre-recruits in the fishery. This implies an increase in wastage of under-sized and, in particular, soft-shelled pre-recruits in the fishery in 2009.

The trawl survey **exploitation rate index** increased slightly in 2009 following a decline since 2006. The **pre-recruit fishing mortality index** decreased sharply in 2006 and changed little until it more than doubled in 2009.

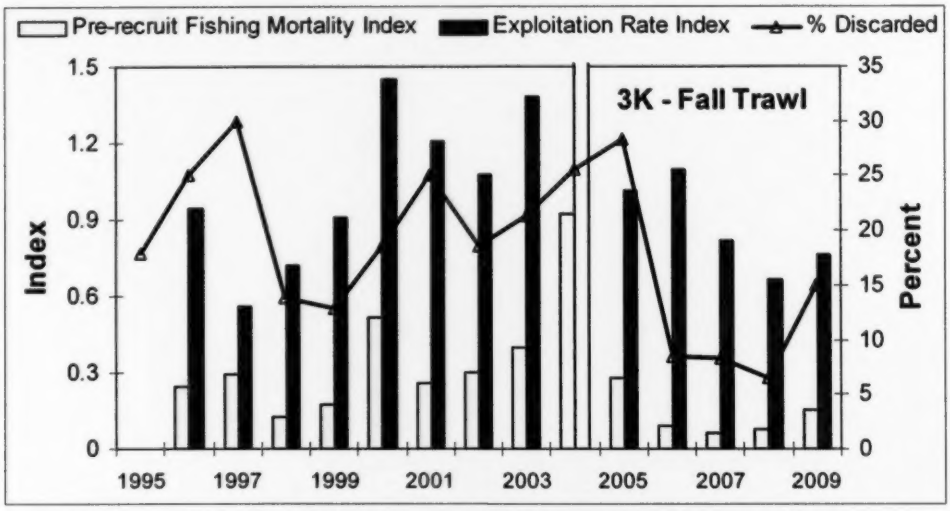


Figure 18: Trends in two Div. 3K offshore mortality indices (the exploitation rate index and the pre-recruit fishing mortality index) and in the percentage of the catch discarded in the fishery. Anomalously high values for 2004 mortality indices are due to very low 2003 biomass indices.

Division 3K Inshore

Biomass

The **exploitable biomass** decreased in 2009. The collaborative fall trap survey exploitable biomass index changed little during 2004-2008 before decreasing substantially in 2009 (Fig. 19).

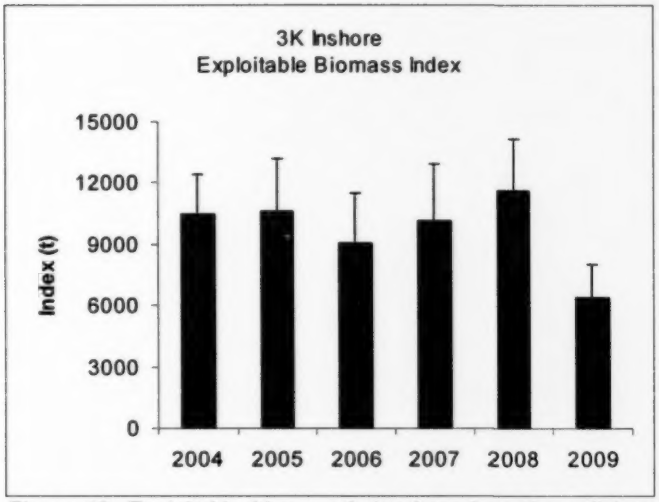


Figure 19: Exploitable biomass index based on the collaborative post-season trap survey in inshore Div. 3K.

Recruitment

Recruitment decreased in 2009 as reflected by the sharp decrease in the post-season exploitable biomass while landings increased little. It is expected to decrease further in 2010. Longer term prospects are uncertain. The CPS pre-recruit biomass index of undersized crabs increased from 2005-2008 but then decreased in 2009 to about the average level (Fig. 20).

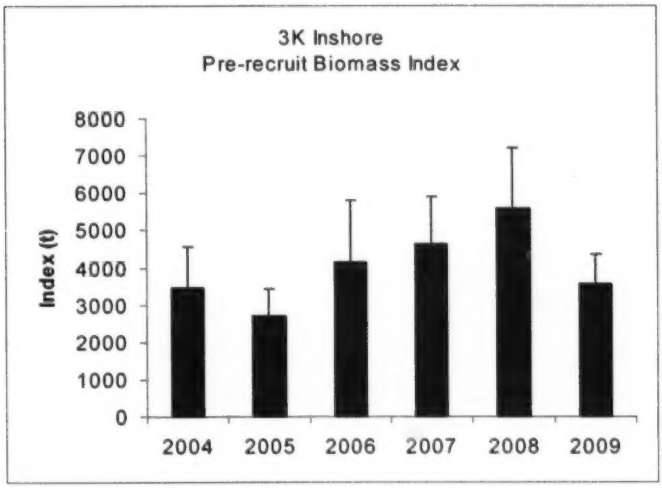


Figure 20: CPS pre-recruit biomass index of undersized (<95 mm CW) crabs from the post-season trap survey in inshore Div. 3K

Mortality

The percentage of the total catch discarded in the fishery (Fig. 21) decreased sharply from 2005 to its lowest level in 2007, was unchanged in 2008, and increased slightly in 2009. This implies little wastage of under-sized and new-shelled pre-recruits in the fishery over the past three years.

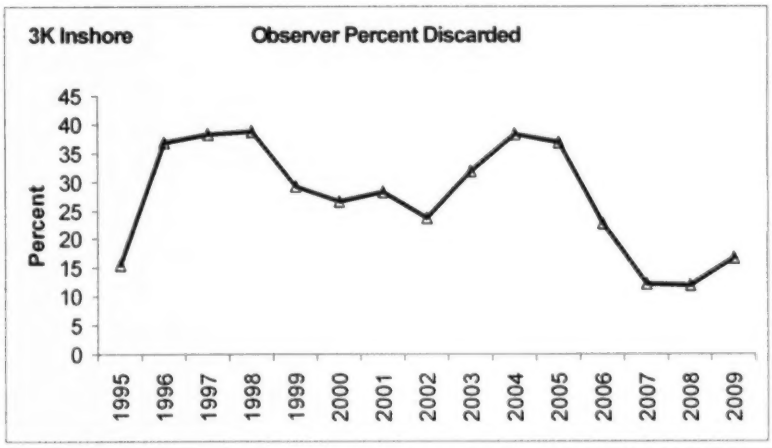


Figure 21: Percentage of the catch discarded in the inshore Div. 3K fishery from observer data.

The trap survey-based **exploitation rate index** (Fig. 22) changed little since 2005. Data are insufficient to estimate **pre-recruit mortality** rates.

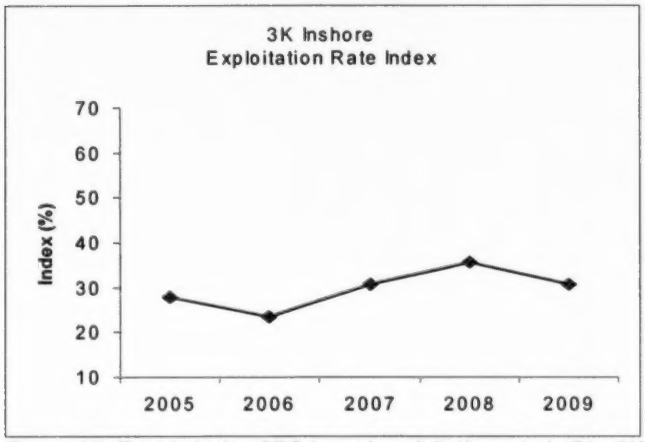


Figure 22: Trends in the CPS based exploitation rate in Div. 3K.

Resource Status, Division 3LNO

Commercial Fishery

Offshore **landings**, mostly in Div. 3L, peaked at 27,300 t in 1999 and decreased to about 22,100 t in 2000 due to a reduction in the TAC (Fig. 23). **Landings** remained at 22,000-25,000 t since 2000. **Effort** increased steadily from 2000-2007 and changed little since.

Inshore landings in Div. 3L (Fig. 23) peaked in 1996 at 7,900 t. They declined to 4,700 t in 2000, increased to 6,800 t in 2003, and decreased slightly to 6,100 t in 2005 due to changes in the TAC. **Landings** increased by 15% from 6,100 t in 2005 to 7,000 t in 2009. Div. 3L inshore **effort** decreased by 23% from 2005-2008, but increased by 11% in 2009.

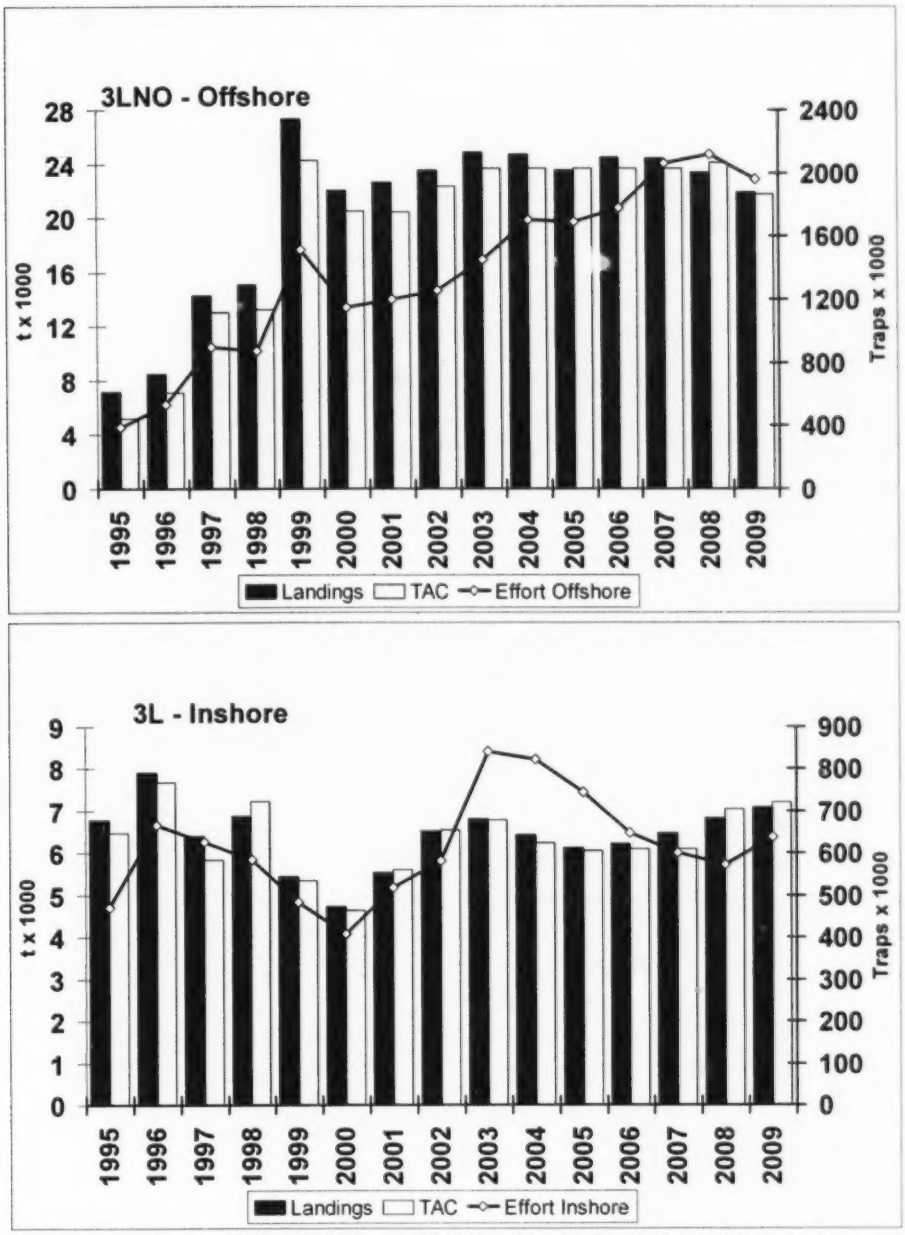


Figure 23: Trends in TAC, landings, and fishing effort in Div. 3LNO offshore (above) and Div. 3L inshore (below).

Commercial CPUE (Fig. 24) indicates that fishery performance has deteriorated offshore but improved inshore over recent years. **Offshore Div. 3LNO CPUE** declined steadily from 2000-2008, to the lowest level since 1991, and was unchanged in 2009. The CPUE series is considered unreliable in this area due to a high degree of inaccurate reporting. **Inshore Div. 3L CPUE** increased by 53% from 2004-2008 before decreasing slightly in 2009.

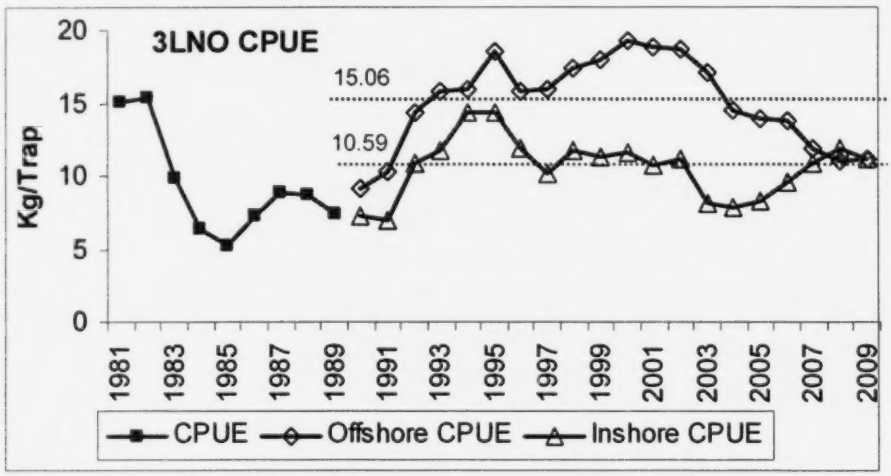


Figure 24: Trends in Div. 3L inshore and Div. 3LNO offshore commercial CPUE in relation to their long-term averages (dotted lines).

Div. 3LNO Offshore

Biomass

The **exploitable biomass** has recently increased. The exploitable biomass index from the trawl survey declined steadily from 2001-2007 but has since more than doubled (Fig. 25). The CPS index declined steadily from 2004-2008 but increased in 2009 (Fig. 25).

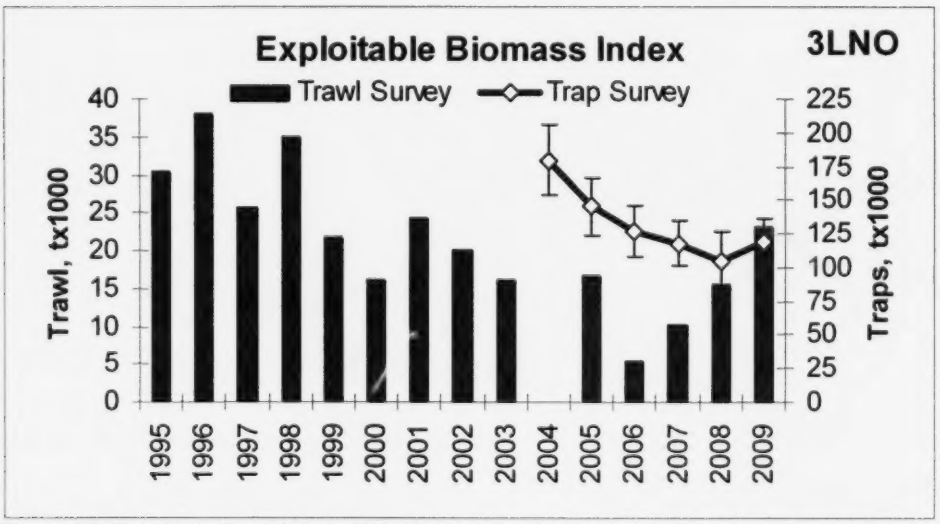


Figure 25: Trends in the offshore Div. 3L exploitable biomass indices based on post-season trawl and trap surveys; the trawl survey was incomplete in 2004.

Recruitment

Both post-season surveys indicate that **recruitment** has been increasing and is expected to increase further over the next two to three years. The recent increase is reflected by the increase in the post-season exploitable biomass indices while landings changed little. Increased recruitment for 2010 is reflected by an increase in biomass indices of legal-sized new-shelled adults in both 2009 post-season surveys. Recruitment is expected to increase further in the short term following 2010. This is indicated by the continued increase in both post-season survey pre-recruit indices to 2009 (Fig. 26).

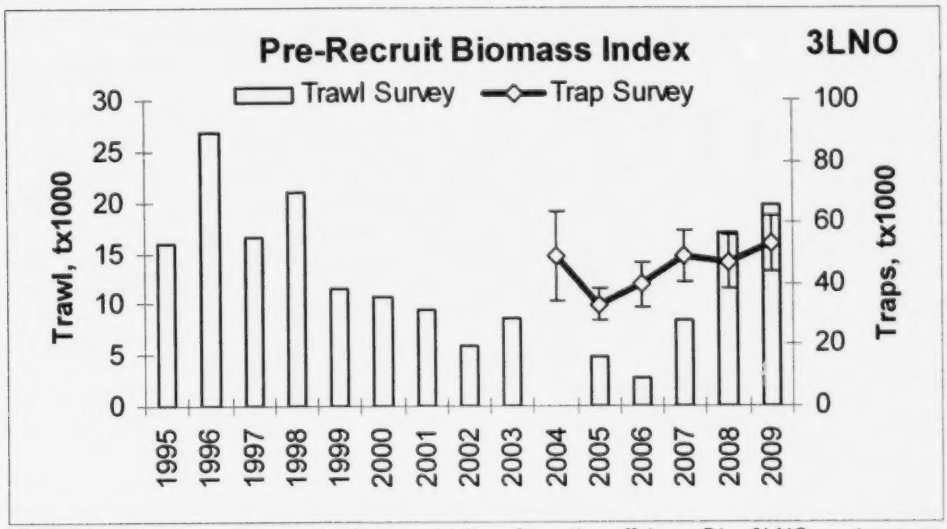


Figure 26: Trends in pre-recruit biomass indices from the offshore Div. 3LNO post-season trawl survey and the CPS trap survey; the trawl survey was incomplete in 2004.

The recent steady increase in the post-season trawl survey pre-recruit index reflects the progression of a group of adolescents in the trawl survey size distributions, with a modal size of about 90 mm CW in 2009. These adolescents are expected to provide increasing recruitment for 2-3 years following 2010.

Mortality

The percentage of the total catch discarded in the fishery (Fig. 27) increased sharply in 2008 from a low level during 2004-2007. It decreased in 2009 implying reduced wastage of pre-recruits, primarily sub-legal sized, in the fishery in 2009.

Both the **exploitation rate index** and the **pre-recruit fishing mortality rate index** peaked in 2008 but decreased in 2009. The latter index was at its lowest level in 2009.

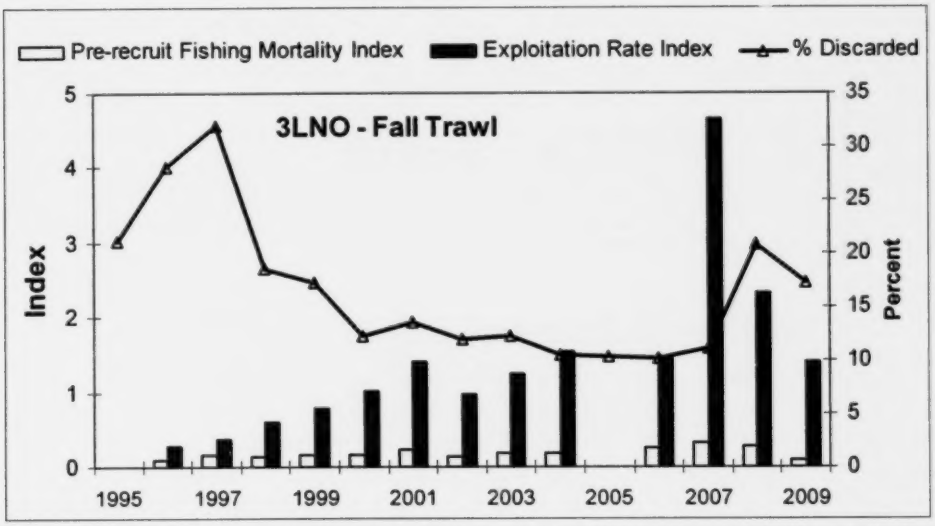


Figure 27: Trends in two offshore Div. 3LNO mortality indices (the exploitation rate index and the pre-recruit fishing mortality index) and in the percentage of the catch discarded in the fishery. Mortality indices were not calculated for 2005 because the survey was incomplete in 2004.

Div. 3L Inshore

Biomass

The post-season trap survey index (Fig. 28) indicates the **exploitable biomass** has declined gradually since 2006.

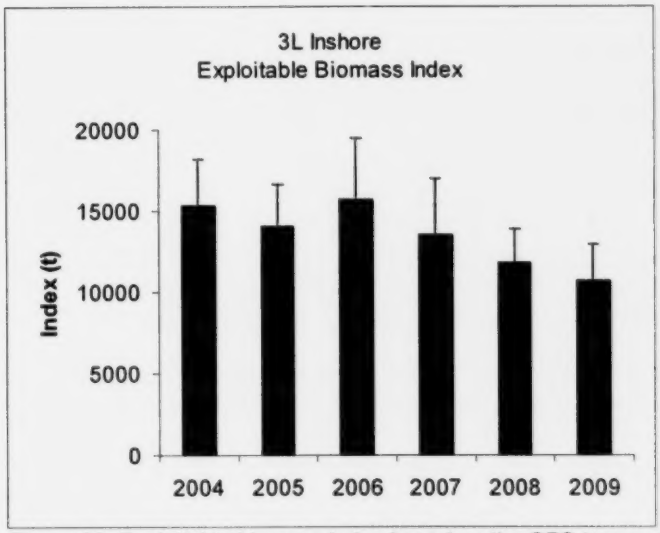


Figure 28: Exploitable biomass index based on the CPS trap survey in inshore Div. 3L.

Recruitment

Recruitment is expected to change little for 2010 as reflected by no change in the catch rate of legal-sized new-shelled adults in the CPS trap survey in 2009. Overall, **recruitment** prospects, beyond 2010, have recently improved, but there is considerable spatial variability (Fig, 29).

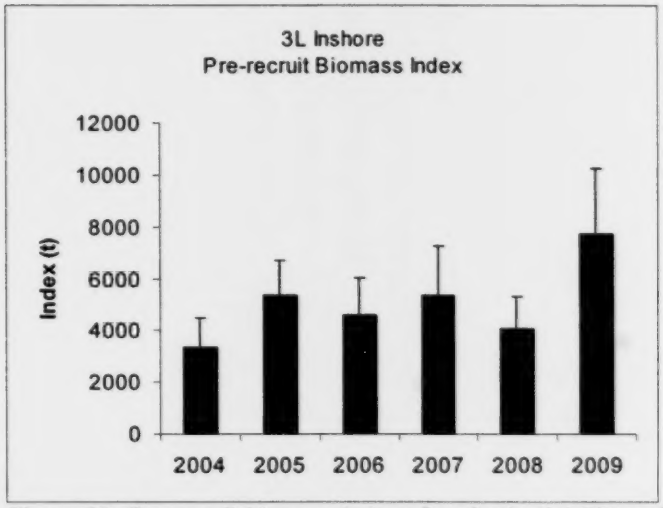


Figure 29: Pre-recruit biomass index of undersized (<95mm CW) crabs from the CPS trap survey in inshore Div. 3L.

Mortality

The percentage of the total catch discarded in the fishery (Fig. 30) increased in 2008 to about the long-term average and decreased in 2009, implying relatively low wastage of under-sized and new-shelled pre-recruits in the 2009 fishery. However, this index is biased by annual variation in spatial distribution of observer sampling.

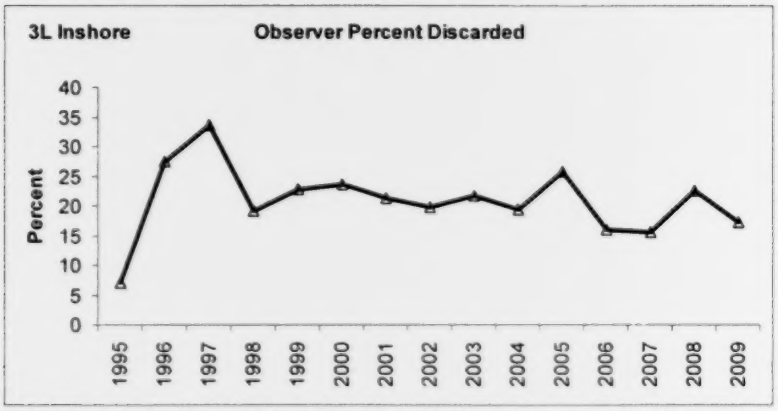


Figure 30: Percentage of the catch discarded in the inshore Div. 3L fishery.

The trap survey-based **exploitation rate index** changed little from 2005-2007 but has since increased (Fig. 31). Data are insufficient to estimate **pre-recruit mortality** rates.

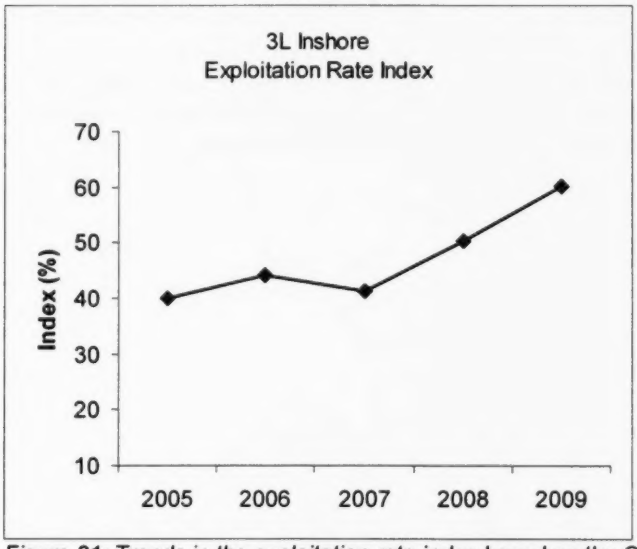


Figure 31: Trends in the exploitation rate index based on the CPS trap survey in Div. 3L.

Resource Status, Subdivision 3Ps

Commercial Fishery

Landings (Fig. 32) from offshore areas have been about twice as high as those from inshore areas in recent years. Landings from both offshore and inshore areas were at their highest level during 1999-2002.

Offshore landings increased by 57% from 2,300 t in 2006 to 3,600 t in 2009 (Fig. 32). **Effort** decreased by 26% in 2008 to its lowest level since 2001 and was unchanged in 2009. **Inshore landings** more than doubled from 700 t in 2005 to 1,900 t in 2009 while **effort** declined slightly (Fig. 32).

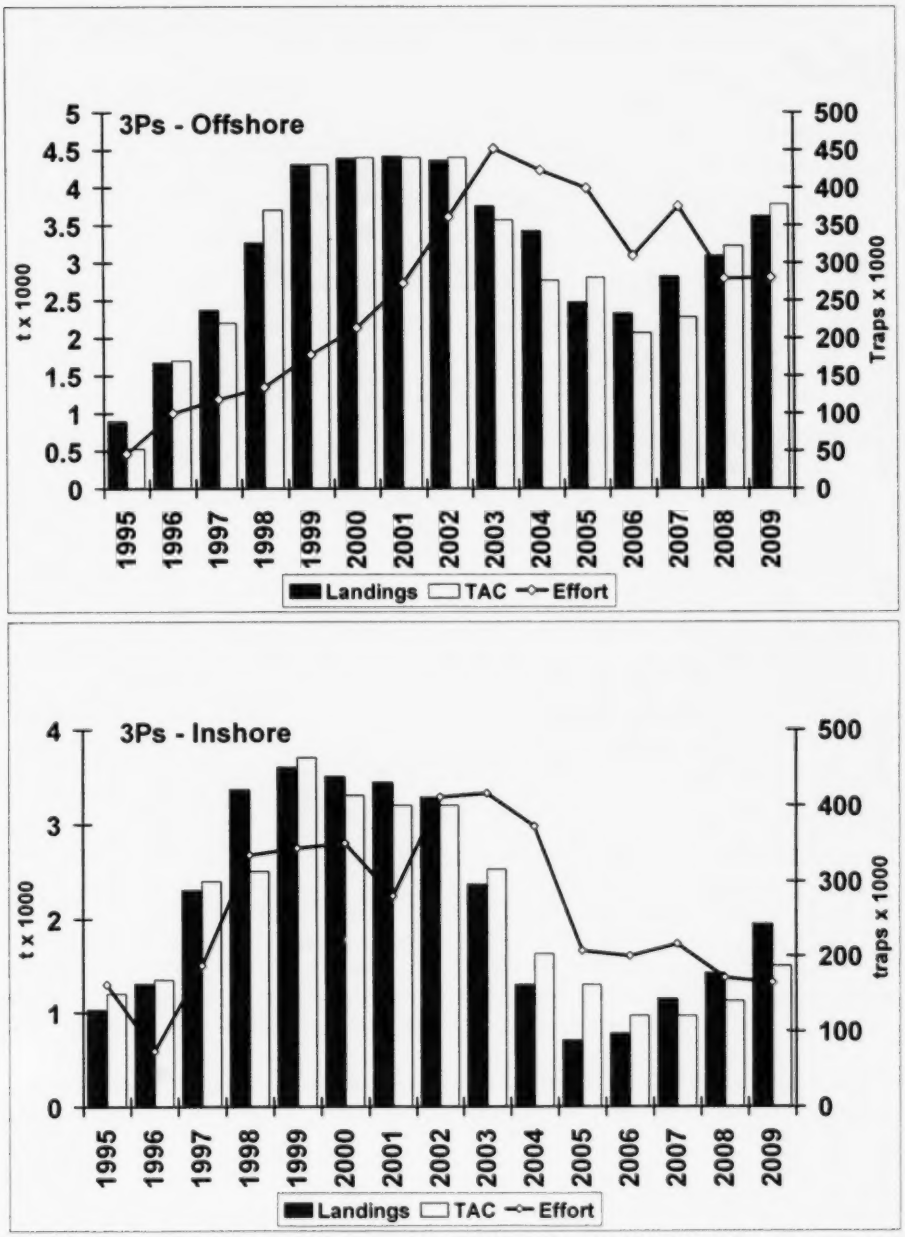


Figure 32: Trends in TAC, landings, and fishing effort in Subdiv. 3Ps offshore (above) and inshore (below).

Commercial CPUE has consistently been higher offshore than inshore (Fig. 33).
Offshore CPUE has increased by 72% since 2007 and is approaching the long-term average.
Inshore CPUE more than doubled since 2005 to exceed the long-term average.

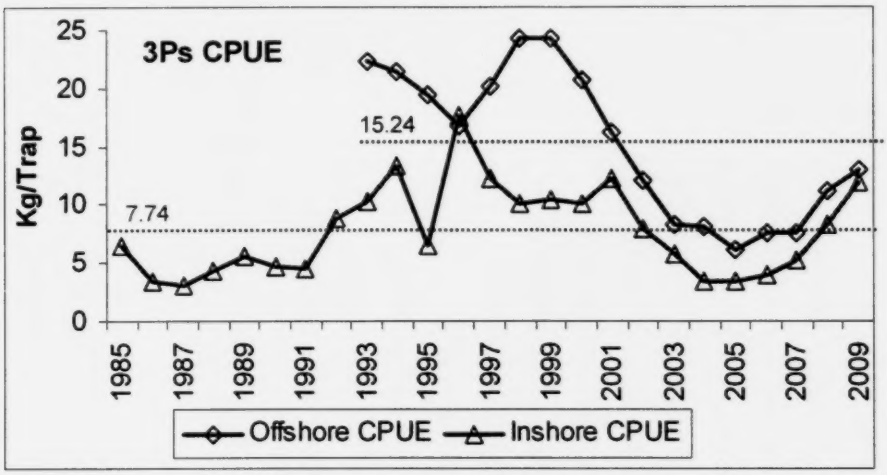


Figure 33: Trends in Subdiv. 3Ps inshore and offshore commercial CPUE in relation to their long-term averages (dotted lines).

Subdiv. 3Ps Offshore

Biomass

The **exploitable biomass** has recently increased. The pre-season trawl survey exploitable biomass index increased since 2007 while the post season trap survey index more than doubled since 2004 (Fig. 34). The 2009 trawl survey index was the highest since 2000.

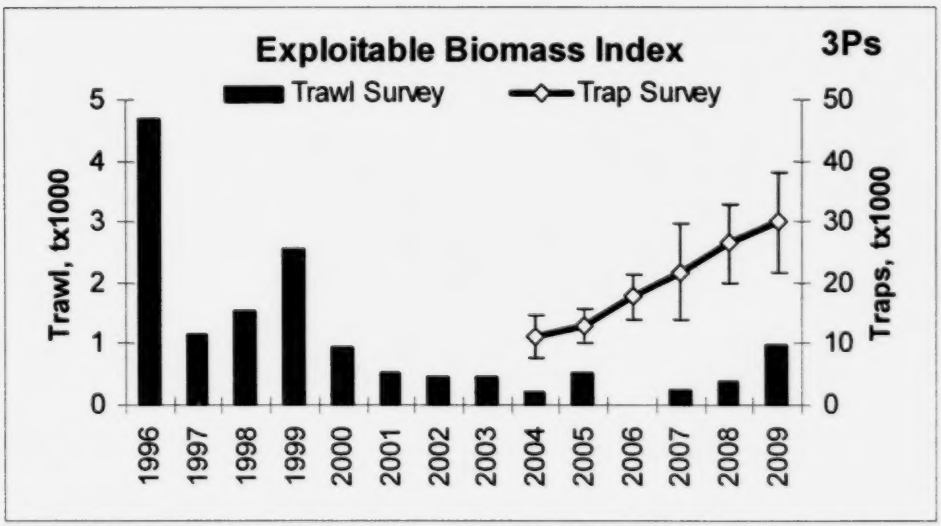


Figure 34: Trends in the offshore Subdiv. 3Ps exploitable biomass indices from the pre-season trawl survey and the CPS trap survey; the trawl survey was incomplete in 2006.

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Recruitment

Recruitment has recently increased as reflected by an increase in biomass while landings increased. Recruitment is expected to remain strong for 2010, as reflected in little change in the CPS survey catch rate of new-shelled legal-sized crabs. Prospects remain promising for the short-term following 2010. The pre-season trawl survey pre-recruit index has steadily increased since 2007 while the CPS trap survey index has varied without trend (Fig. 35).

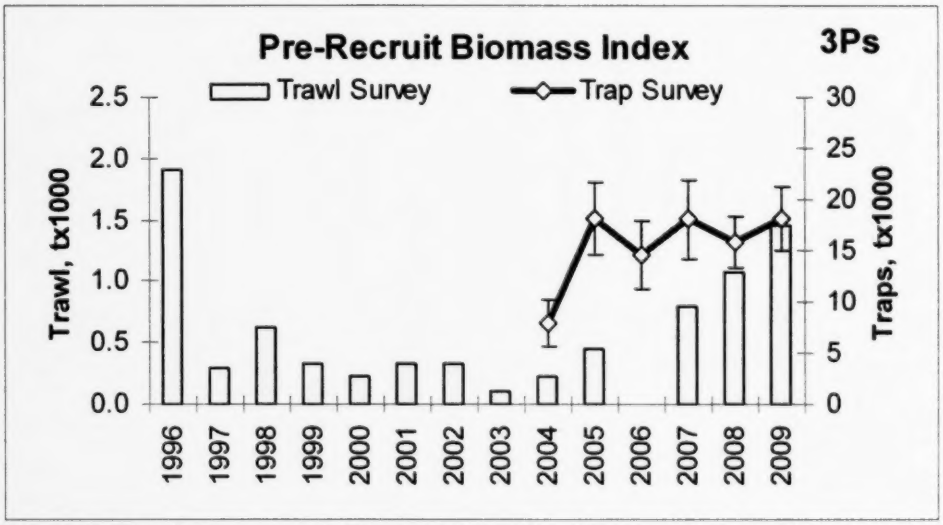

Figure 35: Trends in pre-recruit biomass indices from the pre-season trawl survey and the CPS trap survey in Subdiv. 3Ps; the trawl survey was incomplete in 2006.

Mortality

The percentage of the total catch discarded in the fishery (Fig. 36) almost doubled to about 45% in 2005 and declined markedly to about 20% in 2009, implying a reduction in wastage of pre-recruits in recent years. The percent discarded in Subdiv. 3Ps is generally higher than in other areas as it includes a larger component of under-sized crabs, an unknown portion of which is comprised of small adults that will never recruit to the fishery.

Exploitation and pre-recruit mortality rate indices based on trap and trawl surveys have both decreased since 2007 (Fig. 36). The pre-recruit index is at its lowest level since 1996.

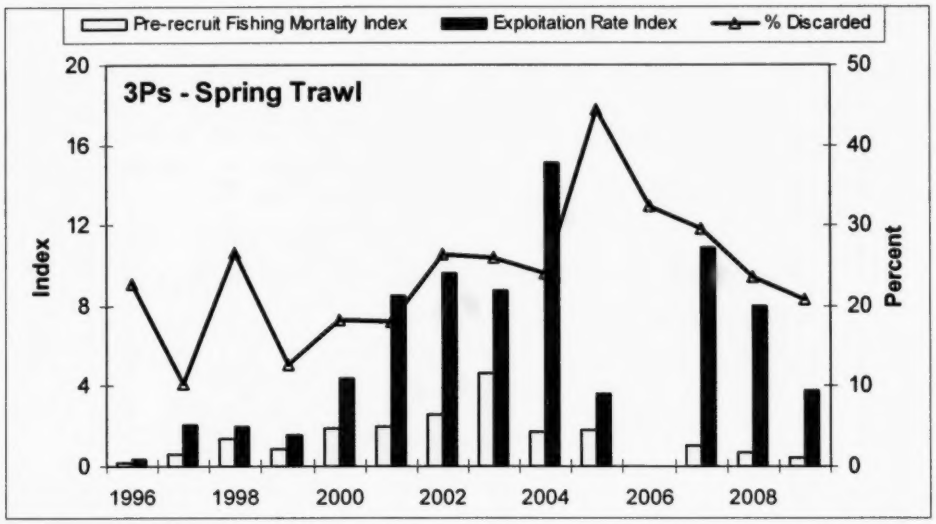

Figure 36: Trends in two offshore Div. 3Ps mortality indices (the exploitation rate index and the pre-recruit fishing mortality index) and in the percentage of the catch discarded in the fishery. Mortality indices were not calculated for 2006 because the 2006 survey was incomplete.

Subdiv. 3Ps Inshore

Biomass

The **exploitable biomass** appears to have peaked. The CPS trap survey exploitable biomass index increased substantially from 2006-2008 but decreased slightly in 2009 (Fig. 37).

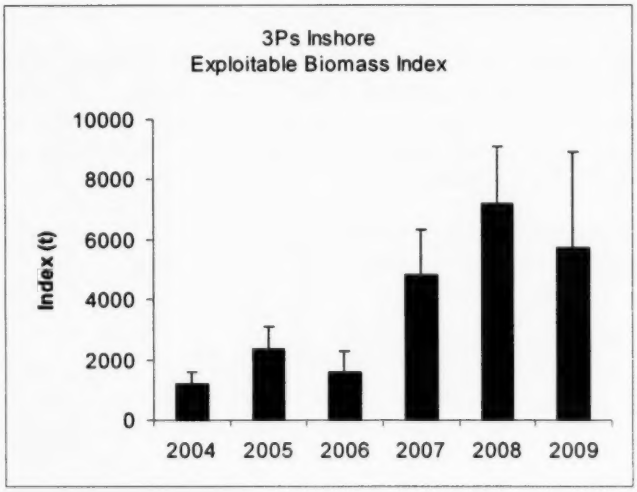

Figure 37: Exploitable biomass index based on the collaborative post-season trap survey in inshore Subdiv. 3Ps.

Recruitment

Recruitment has decreased for 2010, as reflected in a decrease in the CPS survey catch rate of new-shelled legal-sized adults. However, prospects remain promising in the short term following 2010. The CPS trap survey pre-recruit biomass index peaked in 2007 and has since decreased, to remain above the 2004-2006 level (Fig. 38).

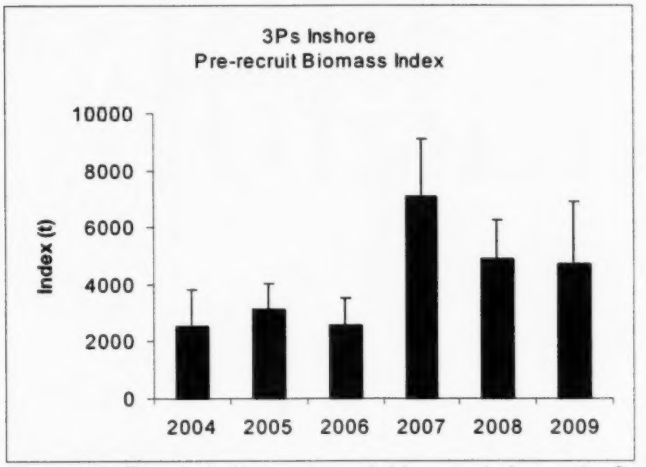

Figure 38: Trends in the pre-recruit biomass index crabs from the CPS trap survey in inshore Subdiv. 3Ps.

The pre-recruit biomass indices for this subdivision include a high proportion of small adults that will never recruit to the fishery.

Mortality

The percentage of the total catch discarded in the fishery (Fig. 39) was at its highest, about 60%, in 2005 and 2006. It has since decreased substantially to about 30% in 2008 implying reduced wastage of pre-recruits in the fishery. It increased slightly in 2009.

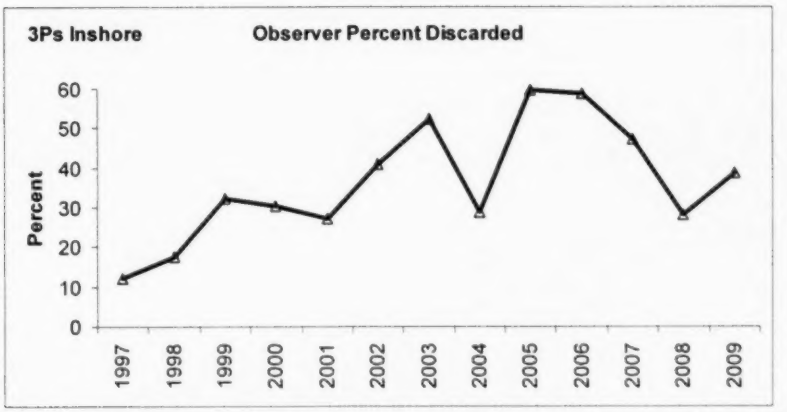

Figure 39: Trends in the percentage of the catch discarded in the inshore Subdiv. 3Ps fishery.

The CPS trap survey-based **exploitation rate index** fluctuated without trend during 2005-2009. Data are insufficient to estimate **pre-recruit fishing mortality** rates.

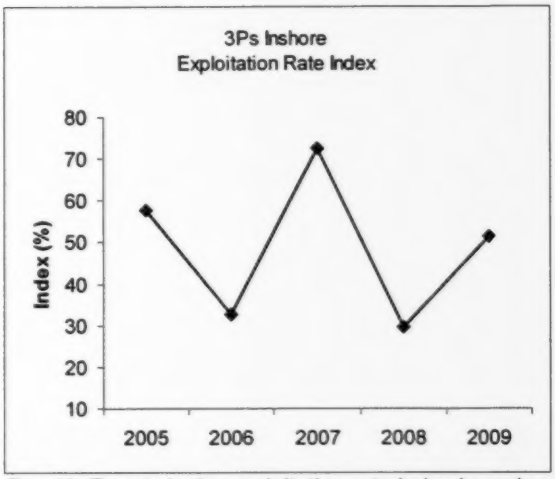

Fig. 40: Trends in the exploitation rate index based on the CPS trap survey in inshore Subdiv. 3Ps.

Resource Status, Division 4R

Commercial Fishery

Landings (Fig. 41) have generally been comparable between inshore and offshore areas; TACs have not been taken since 2002. **Offshore landings** and **effort** have been variable in recent years after reaching historical lows in 2006. **Inshore landings** and **effort** have steadily declined since 2004, to historical lows in 2009. Spatial distribution of inshore effort has been highly variable in recent years.

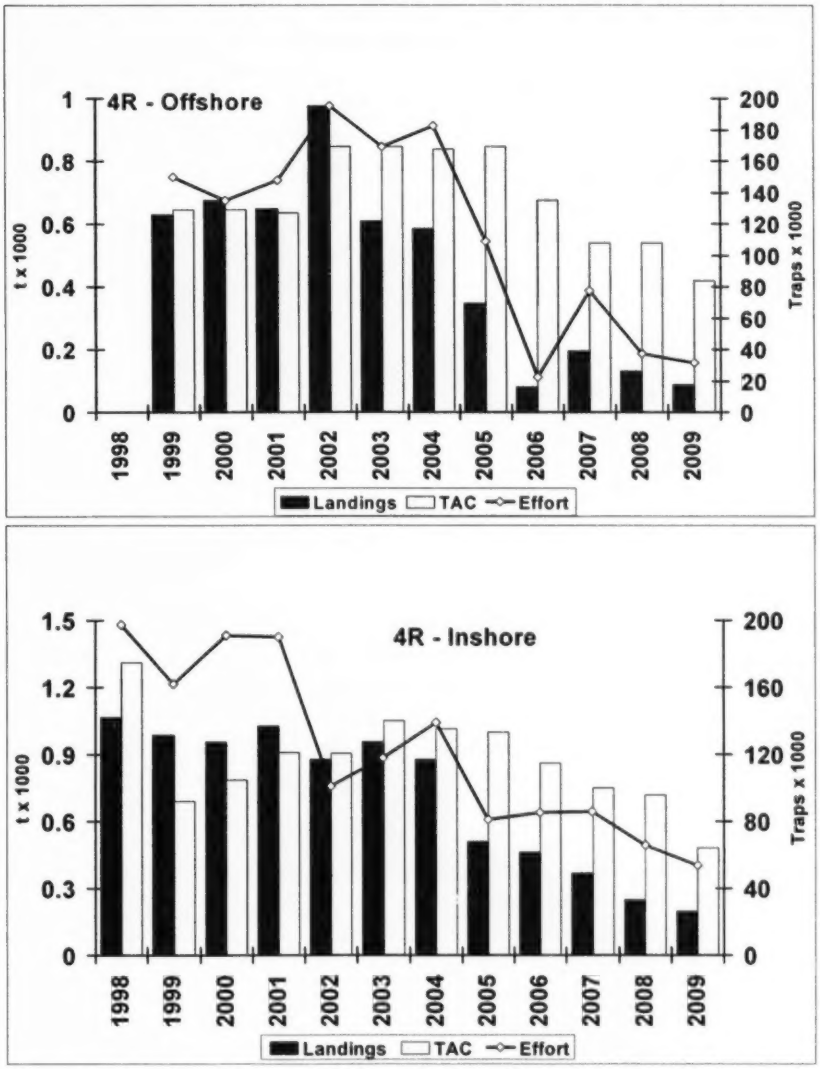

Figure 41: Trends in TAC, landings, and fishing effort in Div. 4R offshore (above) and inshore (below).

Commercial CPUE (Fig. 42) has been higher in inshore than in offshore areas but low relative to other divisions. **Offshore CPUE** has remained below the long-term average since 2003. **Inshore CPUE** has steadily declined since 2002 to its lowest level in 2009.

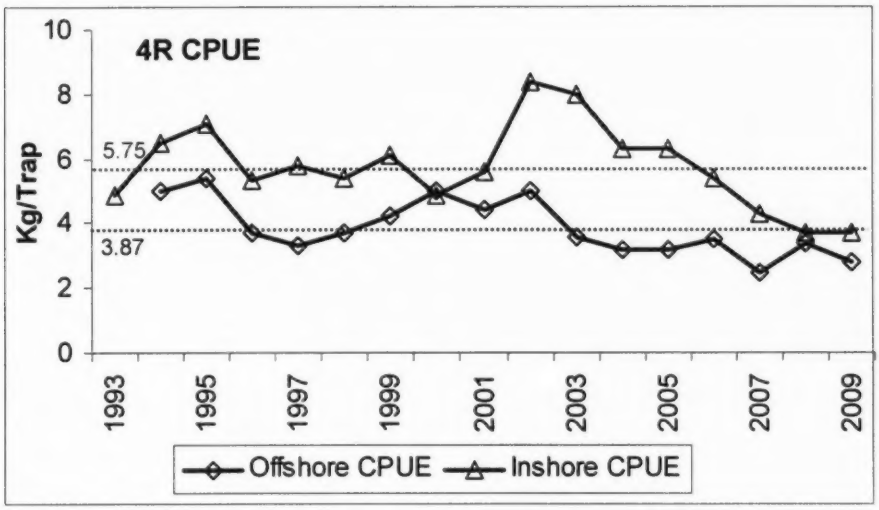

Figure 42: Trends in Div. 4R inshore and offshore commercial CPUE in relation to their long-term averages (dotted lines).

Div. 4R Offshore

Biomass

The **exploitable biomass** is low as reflected by poor fishery performance since 2004.

Recruitment

Recruitment has been low in recent years, as reflected in the prolonged low exploitable biomass. Longer-term recruitment prospects are unknown.

Mortality

The observer data are insufficient to estimate the percentage of the catch discarded in the fishery or to infer wastage of pre-recruits. Trends in fishing mortality on either the exploitable or pre-recruit population are unknown.

Div. 4R Inshore

Biomass

Post-season trap survey catch rates show that the **exploitable biomass** has remained generally low over the time series (Fig. 43). The high catch rate in 2005 was due to localized aggregations. Also, the survey was most spatially limited in that year.

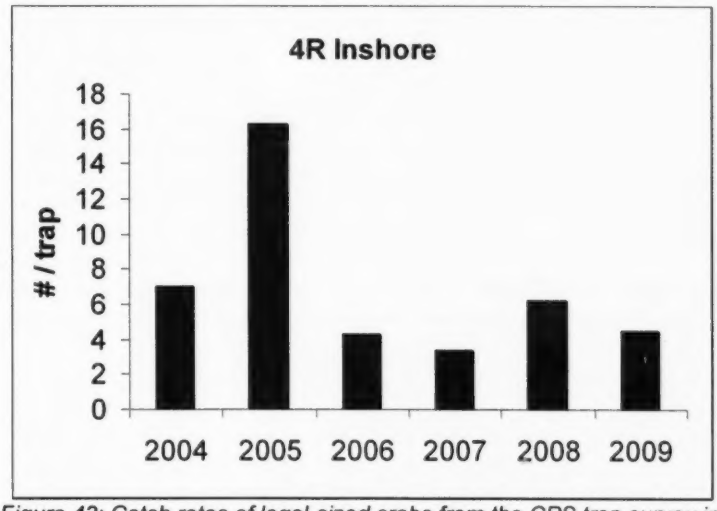

Figure 43: Catch rates of legal-sized crabs from the CPS trap survey in inshore Div. 4R.

Recruitment

Recruitment is expected to remain low for 2010, as reflected in a low catch rate of new-shelled legal-sized crabs in the 2009 CPS trap survey. It is expected to increase in the short term following 2010, but there is considerable spatial variability. The CPS trap survey catch rate of undersized crabs (Fig. 44) increased substantially in 2009. This increase was mostly due to one southern area.

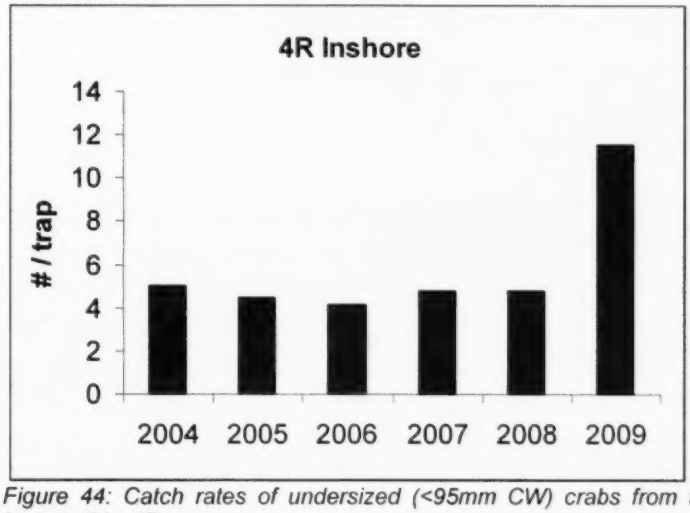

Figure 44: Catch rates of undersized (<95mm CW) crabs from the CPS post-season trap survey in inshore Div. 4R.

Mortality

The observer data are insufficient to estimate the percentage of the catch discarded in the fishery or to infer wastage of pre-recruits. Trends in fishing mortality on either the exploitable or pre-recruit population are unknown.

Sources of Uncertainty

There is uncertainty regarding the effects of changes in some fishing practices (e.g. location, seasonality, soak time, trap mesh size and high-grading) on commercial catch rates (CPUE) and their interpretation. The reliability of the logbook data is uncertain with respect to effort and areas fished. This is especially true of Div. 3LNO offshore, where logbook data are known to be unreliable due to inaccurate reporting.

Pre-recruit fishing mortality indices based on observer data are uncertain due to low observer coverage and, more importantly, seasonal and spatial variation in the distribution of observer coverage.

There is also uncertainty about pre-recruit indices based on undersized crabs, from observer as well as CPS trap surveys, because of unknown and variable proportions of undersized adults (terminally molted) that will never recruit to the fishery. This is especially prevalent in Subdiv. 3Ps where a large component of the total discards is comprised of undersized crabs.

Exploitable biomass and recruitment indices from multi-species trawl surveys may be affected by variation in catchability of crabs by the survey trawl.

There is uncertainty in interpreting trends in exploitable biomass and recruitment from the industry-DFO collaborative trap survey data because the time series is short. There is additional uncertainty related to limited spatial coverage, especially in Div. 2J and 3N. Special-small-meshed traps are included in sampling by this survey to provide an index of future recruitment based on catch rates of sub-legal sized adolescents. However spatial coverage by these small-meshed traps is especially limited. There is also uncertainty associated with the selection of strata for spatial extrapolation of trap survey catch rate data to generate biomass indices.

ADDITIONAL STAKEHOLDER PERSPECTIVES

Division 2J

The CPUE has improved significantly in recent years before declining in 2009. Harvesters feel that a late start to the fishery was a contributing factor to the decline.

Division 3K

The offshore CPUE declined in 2009 after peaking in 2008. Harvesters feel that a late start to the fishery combined with inappropriate soft-shell sampling was a contributing factor to the decline.

The Inshore CPUE declined in most all areas. Harvesters observed good signs of recruitment and no significance observance of soft shelled animals.

Divisions 3LNO

The CPUE declined in 2009 in most inshore areas, but still remained above the long-term average. Harvesters feel that the stock is strong based on positive recruitment, with very little soft shelled animals.

The CPUE remains slightly below the long term average in the offshore, while catch rates remain stable at a high level over recent years. Harvesters feel the stock remains strong, with no significant occurrence of soft shelled crabs.

Division 3Ps

Landings and CPUE have increased for the second consecutive year. Recruitment continues to be strong as harvesters are seeing an abundance of undersized crab. Harvesters remain optimistic about the future of the fishery.

Division 4R

Landings have declined in recent years in both the inshore and offshore areas. The CPUE and landings have increased in Bay St. George, with harvesters seeing positive signs of recruitment.

CONCLUSIONS AND ADVICE

Division 2H

The **exploitable biomass** has decreased in recent years. **Recruitment** has decreased since 2004 and is expected to be low over the next several years.

The effect of maintaining the current level of fishery removals on the exploitation rate in 2010 is unknown as there was no trawl survey in 2009.

Division 2J

The **exploitable biomass** has decreased in recent years. **Recruitment** has recently declined and is expected to remain low for 2010. The **exploitation rate index** declined from 2003-2007 before increasing to 2009. The **pre-recruit fishing mortality index** has remained low since 2005.

Maintaining the current level of fishery removals while biomass is declining will result in an increase in the exploitation rate in 2010.

Division 3K

Offshore

The **exploitable biomass** decreased substantially since 2007. **Recruitment** decreased in 2009 and is expected to be further reduced for 2010, The trawl survey **exploitation rate index** increased slightly in 2009 while the **pre-recruit fishing mortality index** more than doubled.

Maintaining the current level of fishery removals would likely result in an increase in the **exploitation rate** and high mortality on soft-shelled immediate pre-recruits in 2010.

Inshore

The **exploitable biomass** decreased in 2009. **Recruitment** decreased in 2009 and is expected to decrease further in 2010. The trap survey-based **exploitation rate index** changed little since 2005. Data are insufficient to estimate **pre-recruit mortality** rates.

Maintaining the current level of fishery removals would likely increase the exploitation rate in 2010.

Division 3LNO Offshore

The **exploitable biomass** has recently increased. **Recruitment** has been increasing and is expected to increase further over the next two to three years. Both the **exploitation rate index** and the **pre-recruit fishing mortality rate index** peaked in 2008 but decreased in 2009

Increased removals would not likely increase the exploitation rate in 2010.

Division 3L Inshore

The **exploitable biomass** has declined gradually since 2006. Overall, **recruitment** prospects have recently improved, but there is considerable spatial variability. The trap survey-based **exploitation rate index** has increased since 2007. Data are insufficient to estimate **pre-recruit mortality** rates.

Maintaining the current level of fishery removals would likely result in little change in the **exploitation rate** but may increase mortality on soft-shelled immediate pre-recruits in some areas in 2010.

Subdivision 3Ps

Offshore

The **exploitable biomass** has recently increased. **Recruitment** has recently increased and prospects remain promising for the short-term following 2010. **Exploitation and pre-recruit mortality rate indices** based on trap and trawl surveys have both decreased since 2007.

Fishery removals could likely be marginally increased in 2010 without increasing the exploitation rate.

Inshore

The **exploitable biomass** appears to have peaked. **Recruitment** has decreased for 2010 but longer-term prospects remain promising. The post-season trap survey-based **exploitation rate index** fluctuated without trend during 2005-2009. Data are insufficient to estimate **pre-recruit fishing mortality** rates.

Maintaining the current level of fishery removals would likely result in a slight increase in the exploitation rate in 2010.

Division 4R

Offshore

The **exploitable biomass** is low as reflected by poor fishery performance since 2004. **Recruitment** has been low in recent years. Longer-term recruitment prospects are unknown.

The effect of maintaining the current level of fishery removals on the **exploitation rate** is unknown.

Inshore

The **exploitable biomass** has remained low since 2005. **Recruitment** is expected to remain low for 2010. It is expected to increase in the short term following 2010, but there is considerable spatial variability.

Maintaining the current level of fishery removals would have an unknown effect on the **exploitation rate** but may increase mortality on soft-shelled immediate pre-recruits in some areas in 2010.

OTHER CONSIDERATIONS

Reproductive Biology

The percentage of mature females carrying full clutches of viable eggs has remained high throughout the time series.

Fishery-induced mortality on undersized males may adversely affect insemination of females, especially when abundance of larger adults is low.

Bitter Crab Disease (BCD)

This disease, which is fatal to crabs, occurs in new-shelled crab of both sexes and appears to be acquired during molting. There had been a broadly-distributed incidence of **bitter crab disease** during 1996-2006, but the distribution contracted primarily to Div. 3K in 2007. Prevalence has changed little overall in 2008, but there is considerable spatial variability in its distribution.

Management Considerations

Negative relationships between bottom temperature and snow crab CPUE have been demonstrated at lags of 6-9 years, suggesting that cold conditions in early life favor survival and promote subsequent recruitment to the fishery, as they did in the late 1990's (Dawe et al. 2008). A warm oceanographic regime has persisted for more than a decade (Colbourne et al. 2009) suggesting relatively poor long-term recruitment. This is consistent with the relatively low fall trawl survey abundance index of smallest males in recent years.

Reproductive potential is largely protected by conservation measures that exclude females and males smaller than 95 mm CW, including a portion of the adult (large-clawed) males, from the fishery. Therefore exploitation has been considered to have minimal impact on reproductive

potential. However fishery-induced mortality on small (< 95 mm CW) males may adversely affect insemination of females, especially when abundance of larger adults is low.

Fishery-induced mortality on pre-recruits can impair future recruitment. Options for reducing this mortality include early fishing seasons, increasing mesh size and soak time, improving handling practices, and reducing high-grading, as well as trap modifications such as escape mechanisms and biodegradable panels.

Wastage of pre-recruits in the fishery would increase sharply as a recruitment pulse begins to enter the legal size range as new-shelled immediate pre-recruits, especially when the exploitable biomass is low. This wastage negatively affects recruitment and future yield. It increases as the exploitable biomass declines due to an increase in both the relative abundance of pre-recruits and their catchability by traps. Recruitment could be promoted by not allowing the exploitable biomass to become critically low.

There are concerns regarding the utility of the observer data due to low and spatiotemporally inconsistent coverage. Observer-based indices are also biased by inconsistent sampling methods and levels resulting from changing priorities. These deficiencies may have also resulted in premature application of the soft-shelled protocol and grid closures in 2009 which contributed to spatial expansion of fishing effort and increased mortality on soft-shelled immediate pre-recruits.

SOURCES OF INFORMATION

Colbourne, E., Craig, J., Fitzpatrick, C., Senciall, D., Stead, P., and Bailey, W. 2009. An assessment of the physical oceanographic environment on the Newfoundland and Labrador Shelf during 2008. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/032 iv + 20 p.

Dawe, E., Mullowney, D., Stansbury, D., Taylor, D., Hynick, E., Veitch, P., Drew, J., Evans, G., Colbourne, E., O'Keefe, P., Skanes, K., Fiander, D., Stead, R., Maddock Parsons, D., Higdon, P., Paddle, T., Noseworthy, B., and Kelland, S. 2009. An Assessment of Newfoundland and Labrador Snow Crab (Chionoecetes opilio) in 2007. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/057. iv + 160 p.

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